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# Proceedings and Transactions

*of*

# THE TEXAS ACADEMY OF SCIENCE

1945

VOLUME XXIX

SMITHSONIAN INSTITUTION
JUL 27 1949
NATIONAL MUSEUM

Published by the Academy
Austin, Texas
1946

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# THE TEXAS ACADEMY OF SCIENCE

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# DEDICATION AND FOREWORD

As a tribute to the great personal effort and distinguished editorial work of Mr. L. W. Blau, Editor of the Proceedings and Transactions for 1945, the Texas Academy of Science voted unanimously to dedicate to him this volume of the *Proceedings and Transactions*. Mr. Blau has a distinguished record of service to the Academy and to the advancement of science in Texas.

This volume of the *Proceedings and Transactions* is considerably larger than other volumes in the past, due primarily to the inclusion of a larger number of fine papers and the complete Membership List. Great difficulty was experienced in securing a printer who had available adequate manpower and paper. This volume has been delayed somewhat due to the difficulty in assembling the papers and abstracts. Every effort was made to secure as many papers as possible in order that this volume might reflect the true excellence of the Academy's work.

The opinions expressed in this volume are those of the authors, and publication herein is not necessarily to be interpreted as approval of any opinion or any statement by the Academy, its officers, or its members.

THE EDITOR.

JUL 25 1949

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# OFFICERS, BOARDS, AND COMMITTEES FOR 1946

## OFFICERS

F. B. Plummer, *President*, The University of Texas, Austin.
S. R. Warner, *Executive Vice President*, Sam Houston State Teachers College, Huntsville.
W. T. Gooch, *Vice President, Sec. 1*, Baylor University, Waco.
G. E. Potter, *Vice President, Sec. 2*, Agricultural & Mechanical College, College Station.
O. R. Nielsen, *Vice President, Sec. 3*, Texas A. & I. College, Kingsville.
Paul Weaver, *Vice President, Sec. 4*, Gulf Oil Corporation, Houston.
V. H. Schoffelmayer, *Vice President, Sec. 5*, Dallas News, Dallas.
Cornelia M. Smith, *Secretary*, Baylor University, Waco.
A. Garland Adair, *Treasurer*, Texas Memorial Museum, Austin.
C. R. Granberry, *Editor*, The University of Texas, Austin.
G. B. Wolcott, *Executive Assistant to the President*, Southwestern University, Georgetown.
F. A. Barkley, *Chairman of Collegiate Academy*, The University of Texas, Austin.
Miss Greta Oppe, *Chairman of Junior Academy*, Galveston High School, Galveston.

## BOARD OF DIRECTORS

E. P. Cheatum, Southern Methodist University, Dallas.
J. C. Godbey, Southwestern University, Georgetown.
W. P. Taylor, Texas Agricultural & Mechanical College, College Station.
T. S. Painter, The University of Texas, Austin.
W. R. Woolrich, The University of Texas, Austin.
F. B. Plummer, The University of Texas, Austin.
Cornelia M. Smith, Baylor University, Waco.

## BOARD OF DEVELOPMENT

Beauford Jester, Texas Railroad Commission, Austin.
E. D. DeGolyer, DeGolyer & MacNaughton, Dallas.
O. S. Petty, Petty Geophysical Corporation, San Antonio.
L. W. Blau, Humble Oil Company, Houston.
W. R. Woolrich, The University of Texas, Austin.

## EXECUTIVE COUNCIL

F. B. Plummer, *Chairman*, The University of Texas, Austin.
S. R. Warner, Sam Houston State Teachers College, Huntsville.
W. T. Gooch, Baylor University, Waco.
G. E. Potter, Texas A. & M. College, College Station.
O. R. Nielson, Texas A. & I. College, Kingsville.
Paul Weaver, Gulf Oil Corporation, Houston.

V. H. Schoffelmayer, Dallas News, Dallas.
F. A. Barkley, The University of Texas, Austin.
Miss Greta Oppe, Galveston High School, Galveston.
D. O. Baird, Representative, American Association for the Advancement of Science, Sam Houston State Teachers College, Huntsville.

## COMMITTEES

*Finance:*
A. Garland Adair, Texas Memorial Museum, Austin.
O. S. Petty, Petty Geophysical Company, San Antonio.

*Membership:*
F. B. Plummer, *Chairman,* The University of Texas, Austin.
F. A. Barkley, The University of Texas, Austin.
W. P. Taylor, Texas A. & M. College, College Station.

*Research Grants:*
Claude C. Albritton, Jr., *Chairman,* Southern Methodist University, Dallas.
Harold Vance, Texas A. & M. College, College Station.
Gayle Scott, Texas Christian University, Fort Worth.
H. H. Power, The University of Texas, Austin.

*Fellows and Honors:*
P. C. Witt, *Chairman,* Abilene Christian College, Abilene.
S. W. Bilsing, Texas A. & M. College, College Station.
Cornelia B. Smith, Baylor University, Waco.

*Affiliations:*
Luther G. Jones, *Chairman,* Texas A. & M. College, College Station.
W. T. Chambers, Stephen F. Austin College, Nacogdoches.

*Publicity:*
V. H. Schoffelmayer, *Chairman,* Dallas News, Dallas.
A. G. Adair, Texas Memorial Museum, Austin.
Wayne Longnecker, Southern Methodist University, Dallas.
Ellen S. Quillin, Witte Museum, San Antonio.

*Necrology:*
O. A. Ullrich, *Chairman,* Southwestern University, Georgetown.
F. B. Isely, Trinity University, San Antonio.

## FALL PROGRAM—50TH ANNIVERSARY MEETING

E. P. Cheatum, *Chairman,* Southern Methodist University, Dallas.
Frank McDonald, Physics Dept., Southern Methodist University, Dallas.
Ogden Baine, Chemistry Dept., Southern Methodist University, Dallas.
Joe P. Harris, Biology Dept., Southern Methodist University, Dallas.
Wayne Longnecker, Biology Dept., Southern Methodist University, Dallas.

Walter Watson, Social Science, Southern Methodist University, Dallas.
C. A. Nichols, Education, Southern Methodist University, Dallas.
Landon Baker, Biology Dept., North Dallas High School, Dallas.
Dean Slaughter, Southwestern Medical Foundation, Dallas.

*Publications:*
C. R. Granberry, *Chairman*, The University of Texas, Austin.
L. W. Blau, Humble Oil Company, Houston.
W. A. Price, Consulting Geologist, Corpus Christi.
Paul Weaver, Gulf Oil Company, Houston.

*Auditing:*
O. S. Petty, *Chairman*, Petty Geophysical Company, San Antonio.

*Regional Meetings:*
D. O. Baird, *Chairman*, Sam Houston State Teachers College, Huntsville.

*Nominations and Elections:*
W. P. Taylor, *Chairman*, Texas A. & M. College, College Station.
W. R. Woolrich, The University of Texas, Austin.
T. S. Painter, The University of Texas, Austin.
E. P. Cheatum, Southern Methodist University, Dallas.
J. C. Godbey, Southwestern University, Georgetown.

*Library:*
S. W. Bilsing, *Chairman*, Texas A. & M. College, College Station.

*Collegiate Academy:*
Betty Jo Pearce, *Chairman*, Abilene.
Mary Curry, Mary Hardin-Baylor College, Belton.
Fred A. Barkley, The University of Texas, Austin.

*Junior Academy:*
Greta Oppe, *Chairman*, Galveston High School, Galveston.
Addison Lee, Austin High School, Austin.
Mille Mae Floyd, Abilene.
Mrs. Edna W. Miner, Houston.
Velma M. Wilson, Brownsville.
Mrs. J. J. Gelber, Goose Creek.

## SOCIETIES AFFILIATED WITH THE ACADEMY

Central Texas Section, American Chemical Society
Dallas Astronomical Society
Dallas Nature Study Club
Dallas Ornithological Society
El Paso Archaeological Society
Houston Museum and Scientific Society
North Texas Biological Society
San Antonio Science Club
Southwest Section, Society of Experimental

Biology and Medicine
Texas Archaeological and Paleontological Society
Texas Association of Science Teachers
Texas Entomological Society
Texas Society of Pathologists
The Texas Folk-Lore Society
Texas Nature Federation
University Science Club
The Texas Society of College Teachers of Education
West Texas Historical and Scientific Society

## THE TEXAS ACADEMY OF SCIENCE
## RESUME OF FIRST BUSINESS MEETING

Recital Hall, Baylor University
Waco, Texas
November 8, 1945

I. Call to order by President Walter P. Taylor.

II. Statements by the President.

III. Reading of proposed amendments to the constitution.

President Walter P. Taylor asked for a report from Dean O. A. Ullrich, Chairman of the Special Committee appointed to Revise the Constitution and By-laws of the Academy. After Dean Ullrich called attention to the fact that the proposed revised form of the constitution and by-laws was printed in the *Proceedings and Transactions*, pp. 38-46, he noted the salient points of change in the revised organ so that the membership might consider these before the final business meeting. Whereupon a motion was made and unanimously adopted that at this time there be no further reading of the revised form.

IV. Appointment of special committees.

The President appointed Dr. J. G. Sinclair to act as Chairman of the Resolution Committee and to bring a report to the final business session.

V. Reading of proposed amendments to the by-laws.

Dr. Leo T. Murray presented amendments to the proposed by-laws and constitution.

VI. Announcements of officers and chairmen.

Dr. W. T. Gooch called attention to a change in the program in the Physical Science Section pertaining to engineering. The section, Dean W. R. Woolrich, Chairman, will meet in room 310 of the Science Hall.

The report of the Elections Committee was read by Dean W. R. Woolrich. The new officers elected for 1945-1946 are:

*President:* F. B. Plummer, University of Texas.
*Executive Vice-President:* S. R. Warner, Sam Houston State Teachers College.

*Section I Vice-President:* W. T. Gooch, Baylor University.
*Section II Vice-President:* G. E. Potter, A. and M. College.
*Section III Vice-President:* O. R. Nielsen, Texas College of Arts and Industries.
*Section IV Vice-President:* Paul Weaver, Gulf Oil Company.
*Section V Vice-President:* V. H. Schoffelmayer, Dallas Morning News.
*Secretary:* Cornelia M. Smith, Baylor University.
*Assistant Secretary:* G. B. Woolcott, Southwestern University.
*Editor:* C. R. Granberry, University of Texas.
*Member of the Board of Directors:* T. S. Painter, University of Texas.

It was announced by action of the Executive Board that A. Garland Adair was named treasurer.

VII. Election of new members.

President Taylor called for a meeting of the Constitution and Judiciary Committee immediately following the evening program in the President's suite, Hotel Raleigh.

Respectfully submitted,
CORNELIA M. SMITH, *Assistant Secretary.*

## RESUME OF FINAL BUSINESS MEETING

Recital Hall, Baylor University
Waco, Texas
November 10, 1945

I. Call to order by the President, Dr. Walter P. Taylor.

II. Report of President: Statement of projected plans for continued work of President, Dr. Walter P. Taylor, read and heartily endorsed. (See Report of the President following.)

III. Report of Secretary: Report of Secretary, Dr. Leo T. Murray, in which a brief summary of the years activities were reported, was adopted.

IV. Report of Treasurer: Report of Acting Treasurer, Dr. Leo T. Murray, read and approved.

V. Report of Auditing Committee: Report of Auditing Committee made by Dr. Leo T. Murray in absence of Mr. Petty. Material presented, and approved.

VI. Report of other officers: Report of A.A.A.S. Committee made by Dr. Bilsing was approved.

VII. Report of Board of Directors: Report of Board of Directors read by Dean Ullrich, Chairman. Adopted.

VIII. Reports of Executive Council: Report of Executive Council given by President Taylor, Chairman, adopted, and placed on file.

   a. Section I. W. R. Stephens, Vice-President, made the report and it was accepted.
   b. Section II. J. G. Sinclair, Vice-President, presented the report. It was accepted.

- c. Section III. Dean Winkler, Vice-President. No report given.
- d. Section IV. H. Vance, Vice-President, read the report, which was approved.
- e. Section V. J. M. Heiser, Vice-President, presented a plan whereby industrialists and scientists cooperated in an exchange of programs. The plan was enthusiastically received, and approved.

IX. Reports of Standing Committees:

- a. Program: Dr. George E. Potter proposed that a plan such as the one made by Mr. Heiser, Vice-President of Section V, be presented in written form to the incoming officers in order that a similar procedure might be followed by others in planning the annual programs. Proposal approved.
- b. Publications: Dr. W. L. Blau's report adopted and gratitude extended for excellent work.
- c. Affiliations: Report given by Dr. Murray in absence of Dr. Leake. Affiliations listed on pp. 13 and 14 of recent *Transactions*. Number of affiliations listed last year, sixteen, number listed at present, nineteen.
- d. Junior Academy: Committee on Junior Academy report given by Dr. Murray in absence of Miss Oppe. Adoption of the report together with supplementary addition made and approved.
- e. Finance: Report given by Dr. Murray for Committee on Finance. Approved.
- f. Library: Routine report of Library Committee given by Dr. Bilsing, approved and adopted.
- g. Membership: Report of Membership Committee presented by Dr. Ullrich, approved.
- h. Regional Meetings: Report of Chairman, Dean Woolrich, of the Regional Meetings Committee approved.
- i. Research Grants: Report of Research Grants Committee, read by Dr. Plummer, approved.
- j. Collegiate Division: Report of Collegiate Division given by Dr. Greulach approved. Three parts of the report were referred to special committees. Special thanks extended to Dr. Doak and Dr. Greulach for their fine work.
- k. Special Committee on Fellows and Honors: Paul E. Witt presented the report for Dr. Sellards, Chairman of the committee. Report adopted; however, names on list subject to careful checking.
- l. Handbook Committee:
  1. Report read by Dr. Murray in absence of Dr. Price. Approved, adopted, and problems referred to special committees.
  2. Report on Oberholser, *Manuscript on Texas Birds*, adopted.
- m. Necrology: Report of Necrology Committee read by Mr. Adair for Chairman, Father O'Hara. Report adopted names on list, however, subject to careful checking.

n. Special Committee on Financing: Report of committee adopted and referred to the Board of Directors for further consideration.

o. Publicity: Report by Victor Schoffelmayer approved and placed on file.

p. Local Arrangements: Committee on Local Arrangements report given by Dr. Gooch, accepted and approved.

q. Resolutions: Report of Resolutions Committee read by Dr. Sinclair, adopted.

r. Reading and voting on amendments and by-laws to the constitution: Presented by the Chairman of the Revision Committee, Dean Ullrich. After each item had been carefully annotated, it was approved. The revision of the Revised Constitution to be added to this report in mimeographed form.

Respectfully submitted,
CORNELIA M. SMITH, *Assistant Secretary.*

## REPORT OF THE PRESIDENT
## TEXAS ACADEMY OF SCIENCE, WACO, TEXAS

November 10, 1945

In a letter written to all members of the Academy, shortly after taking office, your President suggested that the objectives of the Academy are of sufficient importance to justify a membership of at least 5,000 persons in Texas. This is still very true. Efforts during the past year have not sufficed to more than keep the Academy abreast of its membership at the beginning of the year.

May I now call your attention to some items to which early and pointed attention should be given?

1. Of number one priority is the financing and endowment of the future work and publications program of the Academy.

It is hoped this may be effectively handled by the new committee which has been proposed by Special Committee on Finance and Development, and the enlarged organization which will come out of this.

2. There should be a continued strengthening of the publication program.

The splendid work of Editor L. W. Blau has shown some of the possibilities in Academy publications. The foundation so soundly laid by him should be built upon until our Proceedings and Transactions are second to none in the country. In addition to this, some form of monthly publication should be published for circulation to all members. Seemingly, only in this way—that is, by giving obvious, concrete, and continuous service to the members—can their numbers and interest be increased and the future success of the Academy assured.

3. Consideration should be given to the erection of a suitable building to house Academy activities.

4. The Collegiate Division of the Academy is the fastest growing of any one of its departments.

Assistance should be provided to this division so that soon it will have chapters in every institution of higher learning in the State.

5. The work of the Junior Academy should be emphasized.

Some of the best workers in the entire organization should be enlisted to assist with the Junior Division. Seemingly there should be a science club in every high school in Texas of a size sufficient to warrant it. The work of the leaders of the Junior Division has been carried on under many obstacles and they deserve a great deal of credit. There is no part of the Academy's work which is more worthy than this. These young people soon will take the places of the rest of us.

6. The Academy Library should be recognized, a place found for it, and a definite policy adopted as to its future.

Provision should also be made for assistance to the Library Committee in the cataloging and care of this valuable collection.

7. The work on research grants should be systematized and the policies made clear to the members of the Academy so that all available moneys may be promptly allotted for the benefit of the scientific work of the Academy members.

8. Regional meetings should be resumed at an early date. This should be emphasized with all possible support from the general organization. The State of Texas is so big that no one general meeting can serve the purposes of the Academy.

9. Efforts should be made to enlist the official attention and further actual cooperation of Texas institutions of higher learning in the work of the Academy.

It is a matter of regret and concern that some of our foremost institutions in Texas are so lax in their support of the Texas Academy of Science. Perhaps this is in part the fault of the Academy itself. Every institution of higher learning in the entire State of Texas, and all scientists and investigators, wherever they happen to be, should be members of the Academy. More and more attention should be paid to the technical workers and investigators working for the industries in the State of Texas. While we now have a creditable membership among these, we do not have as many as we should.

10. There should be a revision and classification of the affiliated societies.

Every scientific organization in the State should ultimately be affiliated with the Academy so that the organization could serve as a clearing house for scientific activity of Texans wherever located in the State.

11. Efforts should be made to interest large groups of scientific persons in the State who have to now taken little part in our Academy sessions.

Among these are the chemists, the physicists, the medical men, the social sciences, the agriculturists, and the teachers in general.

12. All these items emphasize the desirability of providing a full-

time secretary-treasurer or executive officer working for the Academy, preferably on a full-time basis.

It is hoped that this can be arranged for in the near future.

Strangely enough, and contrary to what we have long thought, it appears that scientific activities are held in even greater esteem in Soviet Russia than they are in the United States of America. Note the following which is typical of many items which appear at intervals in SCIENCE: "A hundred and fifty scientists from 17 foreign countries have joined nearly a thousand Soviet scientists in attending special sessions celebrating the 220 anniversary of the foundation of the Academy of Sciences, U. S. S. R. Foreign countries represented are the United States, Great Britain, France, Canada, China, India, Australia, Poland, Czechoslovakia, Jugoslavia, Bulgaria, Rumania, Mongolian Peoples Republic, Iran, Hungary, Sweden, and Finland. As an evidence of the esteem in which scientists are held in the Soviet Union, the Soviet Government conferred the title of Bureau of Socialist Labor on 13 members of the Academy, and decorations on a large number of scientific workers." The lack of appreciation of science in the United States should be a matter of vital concern. On the Academy falls a part of the responsibility for helping make us over in this respect.

The office of your president has been busy during the year. There have been six releases to the press, seven mimeographed letters to officers and members, 381 individual letters written on Academy business. Much credit is due the office staff of the Texas Cooperative Wildlife Research Unit for interest and assistance.

No organization with which I have ever been connected has had more loyal and effective service than the Academy has enjoyed during the past year from such men as L. W. Blau, our Editor of the present year; Dr. Leo T. Murray, Secretary and Acting Treasurer; Dean W. R. Woolrich, Dr. W. T. Gooch, Dean O. A. Ullrich, Mr. Daniel W. Lay, and a number of others. These men have put in a very large amount of time and energy and thought into the Academy, totaling a substantial contribution to the progress of its work. In a real sense these men are the Academy. Among them there are two whose activities stand out above all the others. These are Dr. L. W. Blau of Houston and Dr. Leo T. Murray of College Station. It is fair to state that the Academy is a going concern and in relatively good condition. This is due more than anything else to the enlightened and unselfish labors of these men.

Respectfully submitted,
WALTER P. TAYLOR, *President.*

## EXECUTIVE COUNCIL MEETING

Recital Hall, Baylor University
November 8, 1945

The following appointments were made:

Dr. Leo T. Murray as Acting Treasurer to fill out the unexpired term of C. J. Hesse, deceased.

A. Garland Adair as Acting Treasurer to fill out the unexpired term of Dr. Murray.

On request of the South Texas Branch, approved inclusion of four additional counties.

Approved Budget.

## THE TEXAS ACADEMY OF SCIENCE
## REPORT OF BOARD OF DIRECTORS

Waco, Texas, Nov. 10, 1945

To the Texas Academy of Science:

The Board of Directors met in the Raleigh Hotel at 4 P.M. Thursday, Nov. 8, and held an adjourned meeting about 1:30 P.M. Friday, Nov. 9, at the same place. Those present were: E. P. Cheatum, Leo T. Murray, W. P. Taylor, O. A. Ullrich, and W. R. Woolrich. On invitation, the President-Elect F. B. Plummer attended the adjourned session but did not vote.

A majority being present, the members of the Board elected O. A. Ullrich chairman and W. R. Woolrich Secretary, and proceeded to transact business.

The Treasurer reported that two life membership dues were paid during the year.

The Treasurer further reported that the Academy has fifteen members in the life membership files inclusive of the two new ones. In this connection he called attention to the fact that there are only $350.00 in the permanent fund from this source whereas under the Articles of Financial Policy adopted Nov. 13, 1937 and amended Nov. 11, 1939 this fund should be $750.00. The point was made that this apparent discrepancy is probably due to the fact that until recent years life membership dues were only $25.00. The members of the Board had no information regarding the policy of the Academy with respect to this fund prior to Nov. 11, 1939.

The Board of Directors unanimously adopted the following motions and submits them for record:

1. That the sum of $100.00 received from two new life members be invested in U. S. Government Bonds, preferably Series G, and the Treasurer is so directed.
2. That the Treasurer be placed under Surety Bond in the sum of $5000.00, the premium to be paid by the Academy.
3. That the Incoming Chairman of the Board of Directors be and is hereby requested to appoint a special committee to investigate the matter of the permanent fund and to submit to the Board appropriate recommendations relative to the transfer of funds from the current to the permanent fund.

There being no further business, the Board adjourned.

OSCAR A. ULLRICH, *Chairman.*

## REPORT OF THE SECRETARY

For the Year November 11, 1944 to November 7, 1945

During the year the Academy has held two regular meetings and no special meetings. The meetings were the regular Annual Meeting held at the Medical Branch of the University of Texas at Galveston, Nov. 9-11, 1944; and a regional meeting of the South Texas Branch held at Corpus Christi, April 14, 1945.

On the combined programs of the two meetings of the year 12 papers were presented before the Section on Physical Science, 27 before the Section on Biological Sciences, 8 before the Section on Social Sciences, 11 before the Section on Geological Sciences, and 11 before the Section on Conservation. Twenty-seven papers were read before symposia and five addresses were given in general meetings.

Two research grants of fifty dollars each were made during the year; one in geology and one in biology. One volume containing the *Proceedings* and the *Transactions* has been published.

The senior Academy had 504 paid up members on Nov. 1, 1945, and 172 still one year in arrears. There are 49 members known to be in the Armed Forces; and, hence, to be considered in good standing until six months after separation from the Services. (See minutes of business meeting, 1942.) In addition to the senior members there are 177 paid up members of the Collegiate Division and 11 paid up chapters of the Junior Division. Of these numbers, 63 are new members of the Senior Academy and 50 are new Collegiate members.

These numbers for the years 1941 to date are given in the table below:

| | Senior Members | Collegiates | Junior Academy |
|---|---|---|---|
| 1941 | 460 | 78 | 25 chaps. |
| 1942 | 679 | 14 chaps. | 32 " |
| 1943 | 505 | 87 | 19 " |
| 1944 | 516 | 7 chaps. | 13 " |
| 1945 | 502 | 177 members | 11 " |

The alternating method of giving the Collegiate Division in the reports makes it less continuous but it is evidently the fastest growing branch of the Academy. The Junior Division is going down in number of members at a significant rate. The Senior Division has shown no significant variation during the five year period except that of 1942. The high numbers of all divisions in that year are probably due to the fact that the A.A.A.S. meetings were held in Dallas in 1941. The report the following year contains the results of activity from the time of the meetings on; and, hence, would show any resulting fluctuation in numbers of members.

Signed,
LEO T. MURRAY, *Secretary.*

## TEXAS ACADEMY OF SCIENCE
## REPORT OF THE TREASURER

Nov. 9, 1944 to Nov. 7, 1945

When Mr. C. J. Hesse, Treasurer of the Texas Academy, was stricken with coronary thrombosis early in May it soon became apparent that the most optimistic view of his illness was that it would be long. Accordingly, Pres. Taylor took a mail ballot of the Executive Council and the undersigned was appointed to act as Treasurer "until permanent arrangements could be made". On May 12 Mr. Hesse passed away. A short time later the records and other materials of the Treasurer's office were moved from the Museum to Science Hall, both on the A. & M. campus.

Three different notices have been sent out during the year to those members who were one year in arrears.

Every care has been taken to gather up the unfinished business left by Mr. Hesse and to continue plans and procedures already inaugurated for the year. It was discovered late in the year that the Executive Council had overlooked the matter of approving the budget. This was attended to by letter ballot. The budget that had been proposed by the Finance Committee when Mr. Hesse was Chairman was adopted.

A full and detailed analysis of the finances of the Academy will be found in the Auditor's Report for this year.

Signed,

LEO T. MURRAY, *Acting Treasurer.*

### EXHIBIT 1

### TEXAS ACADEMY OF SCIENCE

**Statement of Cash Receipts and Disbursements**
**October 25, 1944, to November 3, 1945**

| | | | |
|---|---|---|---|
| Cash balance, October 25, 1944 | | | $*932.12 |
| **Cash Receipts** | | | |
| Dues | | $†1,404.00 | |
| Research grant from A.A.A.S. | | 100.00 | |
| Interest on U. S. Government bonds | | 5.00 | |
| Sale of publications | | 7.25 | |
| Chapter dues of Junior Academy | | 2.00 | |
| Unclassified | | ‡62.95 | 1,581.20 |
| | | | $2,513.02 |
| **Cash Disbursements** | | | |
| Postage | | | |
| President's office | $40.00 | | |
| Library committee | 35.00 | | |
| Membership committee | 20.00 | | |
| Secretary's and treasurer's offices (not allocated) | 78.62 | $173.62 | |
| Stationery and printing | | 42.55 | |
| 1944 meeting expense | | 35.82 | |

| | | |
|---|---|---|
| Payment to Junior Academy | 35.00 | |
| Disbursement of research grant from A.A.A.S. | 100.00 | |
| Audit | 25.00 | |
| Telephone and telegraph | 10.70 | |
| Collegiate division expense | 4.00 | |
| Stenographic service | 15.65 | |
| Chapter dues of Junior Academy paid to treasurer of Junior Academy | 2.00 | 444.34 |
| Cash balance, November 3, 1945 | | $2,068.98 |

| | |
|---|---|
| *Cash balance reported at October 25, 1945 | $ 925.47 |
| Add check to A. & M. Press listed as outstanding but never issued | 6.65 |
| Adjusted cash balance at October 25, 1945 | $932.12 |

†Including two life memberships at $50.00 each.

‡Deposit made on November 14, 1944 but not recorded on books. No explanation available on nature of receipt.

## EXHIBIT 2

## TEXAS ACADEMY OF SCIENCE

### Bank Reconcilement
### First State Bank and Trust Company, Bryan, Texas
### November 3, 1945

Balance per bank statement $2,127.03

Less outstanding checks

| Number | Date Issued | Payee | | |
|---|---|---|---|---|
| 50 | 9/22/44 | Cash | $ *10.00 | |
| 67 | 1/30/45 | Southwestern States Telephone Co. | 3.30 | |
| 78 | 10/26/45 | O. A. Ullrich | 10.00 | |
| 79 | 10/26/45 | A. & M. Press | 1.10 | |
| 80 | 10/29/45 | Leo T. Murray | 1.00 | |
| 81 | 10/29/45 | Mrs. Edna Miner | 2.00 | |
| 82 | 10/29/45 | Mrs. Jane Butler | 11.15 | |
| 83 | 11/ 1/45 | Dr. Leo T. Murray | 15.00 | |
| 84 | 11/ 1/45 | Mrs. Jane Butler | 4.50 | 58.05 |

Balance per books $2,068.98

*This check may not have been issued. No information is available.

## EXHIBIT 3

## TEXAS ACADEMY OF SCIENCE

### Permanent Endowment Fund Investments
### November 3, 1945

| | | |
|---|---|---|
| United States Government Bonds | | |
| Two $100 Series C Bonds purchased in January, 1938, at a cost of $75 each, no interest payable currently, with a present redemption value of $90 each | $ 180.00 | |
| Two $100 Series G Bonds purchased in August, 1943, at a cost of $100 each, interest payable semi-annually at the annual rate of 2½ per cent, with a present redemption calue of $96.20 each | 192.40 | $ 372.40 |
| Share account in First Federal Savings and Loan Association, San Antonio, Texas | | 59.46 |
| | | $ 431.86 |

## EXHIBIT 4

## TEXAS ACADEMY OF SCIENCE

### Junior Academy Division
### Statement of Cash Receipts and Disbursements
### October 25, 1944, to October 20, 1945

| | | |
|---|---|---|
| Cash balance, October 25, 1944 | | $ 29.22 |
| **Cash Receipts** | | |
| Dues | $ 32.00 | |
| Allocation of funds from Texas Academy of Science | 35.00 | 67.00 |
| | | $ 96.22 |
| **Cash Disbursements** | | |
| Texsciana | $ 23.95 | |
| Subscriptions | 6.50 | |
| Postage | 3.00 | 33.45 |
| Cash balance, October 20, 1945 | | $ 62.77 |

Note: This statement was prepared by Mrs. Edna W. Miner, treasurer of the Junior Academy. No amounts were verified by the auditor. See comments in letter.

## REPORT OF THE AUDITOR

November 6, 1945.

Officers and Directors of Texas Academy of Science
College Station, Texas
Gentlemen:

At the request of Dr. Leo T. Murray, treasurer, I have made an examination of the financial records of the Texas Academy of Science for the period from October 25, 1944 to November 3, 1945.

From October 25, 1944 to May 16, 1945 the records were kept by Mr. Curtis J. Hesse. Upon Mr. Hesse's death, Dr. Leo T. Murray, secretary, assumed the duties of treasurer and kept the records to the present date.

In the course of the examination the recorded receipts were traced to the bank. One recorded receipt of $2.00 on April 12, 1945 was not found deposited. Deposits totaling $119.45 made prior to May 17, 1945 were not found recorded on the books. Adjustments were made for these two items. The receipts from dues were checked to a membership list. Ten persons and libraries paid dues during the current year but are not shown as members. All of these collections were made prior to May 17, 1945. Sixteen persons who paid no dues during the current year are listed as paid-up regular members. Approximately fifty-four persons who paid no dues during the current year are listed as collegiate members. Dues are frequently paid in advance. Since no schedule is maintained of dues paid in advance and the dates of payment are not entered on the membership cards, it was impossible to determine whether any of these persons paid dues for the current year prior to October 25, 1944. A recommendation has been made to the treasurer that a schedule of dues paid in advance at November 3, 1945 be prepared for use in checking the membership list next year.

A deposit of $62.95 was made on November 14, 1944 with no explanation as to the nature of the receipt. Most of this amount probably represents the dues collections from some of the members who are not listed in the cash receipts record.

All cancelled checks were examined. Bills were submitted for all disbursements since May 17, 1945. Based on the examination of these items, it is my opinion that all disbursements were properly made.

Cash in the First State Bank and Trust Company, Bryan, Texas, at November 3, 1945 amounted to $2068.98. Confirmation of this balance was received directly from the bank. A Statement of Cash Receipts and Disbursements for the period covered by the examination and a bank reconciliation at November 3, 1945 are presented in this report as Exhibit 1 and 2, respectively.

Subsequent to November 3, 1945 the bill for the printing of 1944 transactions was reported to have been determined at $1650.25. The treasurer states that advertising charges will be collected in an amount exceeding the publication bill. The printing bill was not verified.

A schedule of investments held by the permanent endowment fund is shown as Exhibit 3. The United States Government bonds are in a safety deposit box in the First State Bank and Trust Company, Bryan, Texas, and were examined. Confirmation of the balance in the share account with the First Federal Savings and Loan Association, San Antonio, Texas was obtained.

During the period under examination two life memberships were created by the payment of dues of $50.00 each. According to the Articles of Financial Policy a total of $100.00 should be transferred to the permanent endowment fund and invested. According to the membership list there are now fifteen life members. Only about $400.00 was ever placed in the permanent endowment fund.

The academy is reported to have various items of laboratory equipment located in some of the Texas colleges where research projects financed by the academy have been conducted. The academy also has a stock of printed bulletins. No inventory list of these items is available and it is recommended that one be prepared.

The Statement of Cash Receipts and Disbursements of the Junior Academy Division is presented as Exhibit 4. This statement was prepared by Mrs. Edna W. Miner and none of the amounts was verified. The cash balance of $62.77 on October 20, 1945 was stated to be on deposit with the City National Bank, Houston. A request for a confirmation of the cash balance by the bank brought the reply from Mrs. Miner to Dr. Murray that she had resigned as treasurer of the Junior Academy and that she had sent a check in amount of $79.74 to the chairman of the division. No explanation was given on the difference in the originally reported balance from the amount reported to have been sent the chairman. There was insufficient time to investigate this matter further.

Respectfully submitted,
Nelson D. Durst,
Certified Public Accountant,
College Station, Texas.

## REPORT OF THE FINANCE COMMITTEE

Nov. 9, 1944-Nov. 7, 1945

Prior to Mr. Hesse's death the members of the Finance Committee who reside in College Station (Hesse, Murray, Taylor) held several informal discussion meetings. Ways and means of providing adequate funds for the permanent financing of the program of the Academy were studied.

It was decided to ask a special committee to give its full attention to this matter. Such a committee was formed and will present a hopeful report at this meeting.

The present status of the investments of the Permanent Endowment Fund of the Academy is as follows:

United States Government Bonds

| | |
|---|---|
| Two $100 series C bonds purchased in January, 1938 at a cost of $75 each, no interest payable currently, with a present redemption value of $90 each | $180.00 |
| Two $100 series G bonds purchased in August, 1943 at a cost of $100 each, interest payable semi-annually at the annual rate of 2½% with a present redemption value of $96.20 each | $192.40 |
| Share account in First Federal Savings and Loan Association, San Antonio Texas | $ 59.46 |
| Total | $431.86 |

One hundred dollars has been received during the year for Life Memberships. The constitution requires that this money be put into the Permanent Endowment Fund by the Board of Directors. This committee has notified the Board of the availability of this sum.

The Treasurer of the Texas Academy now handles over $4000 in the course of a year. The Finance Committee is of the opinion that good business practices demand that this officer and the Academy be protected by a bond of not less than $5000. This matter has been called to the attention of the Board of Directors.

There are 15 Life Members of the Academy at this time. If the dues of all of these members was fifty dollars, as at present, not all of it has been invested in the Permanent Fund as required by the constitution. This matter was called to the attention of the Board of Directors.

Signed,
Leo T. Murray, *Chairman Finance Committee.*

## REPORT OF SPECIAL COMMITTEE ON FINANCING

College Station, Texas, September 19, 1945

The meeting was called to order at 2:15 p.m. Dr. S. W. Bilsing, Dr. L. W. Blau, and Dean W. R. Woolrich, chairman of the Committee, were present; Dr. W. P. Taylor and Dr. L. T. Murray attended *ex officio* as president and secretary-treasurer of the Academy.

One preliminary note of optimism was delivered to the group by virtue of Dr. Blau's activity in securing advertising for the new volume of the *Proceedings*. He showed that over $1,800 worth of advertising had been collected through his personal efforts.

It was the agreed policy of the Committee that there should be set up some aggressive group, more or less permanent in nature, whose function it would be to devise new ways of getting ample funds for the publications of the Academy. These publications should include, as a minimum, the annual *Proceedings* and a news sheet published either monthly, bi-monthly, or quarterly. The chairman indicated that we should anticipate a minimum need of $3,000 per year from such new sources and, if possible, this should be increased to $5,000.

The three possible sources seem to be endowment, institutional memberships, and advertising. Dr. Blau pointed out that it is much easier for a manufacturing plant to participate in advertising than in institutional memberships. The chairman indicated the desirability of having more than one possible source of income. In the case of endowment, it is very often "feast or famine," so it is desirable to set up a program including all three of these possible sources.

After considerable discussion it was moved by Dr. Bilsing, seconded by Dr. Blau, and carried *that we set up a Board of Development as a constitutional part of the Academy*. This Board of Development should consist of ten members or fellows. The first members shall be elected upon the adoption of this article of the Constitution for terms of from one to ten years, these terms to be designated at the time of election. Henceforth, one member shall be elected each year by the Texas Academy of Science. The Board of Development shall propose at least two names each year to the Committee on Nominations and Elections for the place to be filled by election that year.

This Board shall devise and put into effect ways and means for the establishment of a sound financial position for The Texas Academy of Science. These ways and means shall include but not be limited to endowments, institutional memberships, and the sale of advertising space in the publications of the Academy.

In a brief discussion and on the proposal of Dr. Murray, it was recommended that the cost of institutional memberships be placed at $20, and that this include one page annually for the institutional member in the *Proceedings*, setting forth the fields of activity of that particular institution. In general, these institutional members will be the four-year colleges teaching science and the social sciences in the State of Texas.

It was agreed that the present Committee would make this report to the president, including the following names of persons suggested for membership on the first Board of Development:

Mr. John Carpenter, Texas Power and Light Company, Dallas
Dr. E. DeGolyer, 1000 Continental Building, Dallas
Mr. Beauford Jester, Railroad Commissioner of Texas, Austin
Mr. J. C. Karcher, 406 Continental Building, Dallas
Mr. Eugene McDermott, 1311 Republic Building, Dallas
Mr. O. S. Petty, Petty Geophysical Company, San Antonio
Mr. V. H. Schoffelmayer, Dallas Morning News, Dallas
Mr. P. H. Walser, State Coordinator of Soil Conservation, 116 Twenty-first Street, Temple
Members of the present Special Committee, as the president sees fit.

At a later date the president of the Academy is to propose the full slate.

W. R. WOOLRICH, *Chairman*,
Special Committee on Financing.

## REPORT OF THE PUBLICATIONS COMMITTEE

Twenty-one hundred copies of Volume XXVIII were printed at a cost of $1650.25. The paper shortage and war condition in general retarded publication; although the copy was delivered to the printer about six weeks earlier than in prior years, the printing was not finished until November 3rd.

Volume XXVIII contains advertising, pursuant to the authorization which was granted by the Academy at the last annual meeting in Galveston. The chairman of the committee desires to express his thanks to these advertising firms for their support of the Academy. We hope that the Academy may continue to receive their support in the future and that other organizations may be added to the list of advertisers in the years to come.

L. W. BLAU, *Chairman*.

## REPORT OF THE HANDBOOK OF SCIENCE COMMITTEE FOR 1945

I. In 1943 an arrangement was made with Dr. Donald Day, an executive of the University Press, Southern Methodist University, Dallas, by which he would endeavor to have a selection of the Handbook manuscripts published by the Texas Geographic Magazine with a credit line stating that the manuscript was from the collection of the Academy's Handbook manuscripts; then to use the type set by the Geographic for re-publication of these papers as part of the volumes necessary to publish all or nearly all the Handbook manuscripts. Dr. Day stated that the University Press was able to underwrite the publication of scientific books for non-profit purposes.

II. Under this plan, 2 papers have been published in the Texas Geographic, but without credit lines to the Academy, and one in the Southwest Review, also published by Southern Methodist University, the latter paper credited to the Handbook collection. These papers are:

1. "Texas Snakes", by H. K. Gloyd, Texas Geographic Mag., vol. 8, 1944, pp. 1-18, no credit line. Illustrated.
2. "Outstanding bird life of Texas", Southwest Review, vol. 30, 1945, pp. 377-381. Manuscript entitled "Texas Birds" by author, H. C. Oberholser. Credit line to Academy.
3. "Climates of Texas", by R. J. Russell, rewritten from the Academy's 1936 manuscript and first published in Annals of Assn. of Amer. Geographers. No credit lines. Currently appearing in Texas Geographic Magazine, Autumn Issue, 1945. No credit line due Academy.

III. Previously published by Anson Jones Press under contract terminated about 1942:

4. "The Vegetation of Texas" by B. C. Tharp. Brochure One, Texas Acad. Sci., Non-Technical Series, 1939. Anson Jones Press, Houston. 74 pp. Illustrated.
5. "Marine Life in Texas Waters" by C. T. Reed. Brochure Two of last series above. Illustrated. 88 pp. 1941.

IV. The present status is that about one-fifth of the papers have been published. The Texas Geographic offers to print three others provided they do the editing to have them brought up to date or otherwise modified to suit their ideas, with cooperation of the authors, but without credit to the Academy. The Chairman has not agreed to this offer, as he is without authority to do so, which would constitute a release of the manuscripts to the authors. In such case, the authors are the ones to determine the places of publication, not the Academy. In view of the desire of the University Press to publish the Handbook volumes, expressed in 1943, it is not recommended that this new offer of the Texas Geographic be accepted at this time. The Chairman has written Dr. E. J. Foscue, editor of the Geographic, again stating the Handbook Committee's plan to edit these papers for revision just before publication and offering to let the Geographic then publish the three papers of their selection, with such other editing as they desire, but with credit lines to the Academy. No answer has yet been received.

Confirmation of the plans of the University Press has been sought since September, but Dr. Day has not replied to any of several requests for enlightenment.

V. Provided the Texas Geographic and University Press do not continue with the program authorized by the Academy in 1943 and at that time requested by Dr. Day, the Handbook Chairman recommends further investigation to secure an underwriter for the volumes. It should be possible to make such a search by publishing a brief note in some journal such as "Science" stating the aims of the Academy in regard to these articles or otherwise publicizing the plan.

Respectfully submitted,

W. ARMSTRONG, *Chairman,*
Handbook of Science Committee,
Corpus Christi, Texas, Nov. 8, 1945.

## REPORT OF THE COMMITTEE ON RESOLUTIONS

Be it resolved that the Texas Academy of Science express its thankfulness to all those who have contributed to the success of its annual programs in Waco, Texas. This includes the local committee under Dr. Gooch, Baylor University, the local press and the press relations committee under Victor Schoffelmayer, and finally the several radio stations that gave freely of their program time.

That the Texas Academy of Science express its thankfulness to Baylor University, the local committee of its faculty and other interested citizens for their efforts to make this meeting a success.

Be it resolved by the Texas Academy of Science that the great personal effort and distinguished editorial work of Mr. L. W. Blau be recognized by a vote of thanks and by dedicating to him the next volume of the *Proceedings and Transactions*.

Be it resolved that the Texas Academy of Science express its great satisfaction with the growth of the Collegiate and Junior Academies. The leaders of these sections may be proud of their achievement in providing future scientists to the Academy and to the State of Texas.

The Texas Academy of Science wishes to record its gratification with the progress of the Collegiate Division and Junior Academy under their able sponsors and sees great value to the future of science in Texas from these inspiring beginnings.

Be it resolved that the Texas Academy of Science express its interest and concern in the proposed measures now before the Congress for the subsidy and utilization of scientific research. One of the most fundamental attributes of scientific investigation and publication is its university of origins and values without regard to either cultural or national boundaries.

It is our hope that nothing will be done to interfere with the free flow of scientific knowledge between the peoples of the world. The advance of knowledge is directly dependent on unhampered freedom of investigation and publication in which the scientist takes complete responsibility for the truth of his statements.

We hope that no planned subsidy will abridge that freedom and no planned economy will channel all scientific effort in the vain hope that increased efficiency will produce superior scientific imagination. The best interests of the United States will be best served by broad geographic representation in any central body which exercises control over organization or funds.

The Academy recognizes that the nation depends upon its scientific personnel for security and defense and expects them individually and in cooperative groups to direct some effort to that end.

Respectfully submitted,
JOHN G. SINCLAIR, *Chairman*,
Resolutions Committee.

## REPORT OF COMMITTEE ON ELECTIONS

Below is given the list of candidates for various offices and the votes received by each. The candidate receiving the highest number of votes in each case is hereby declared elected.

| Office | Candidates | No. of Votes |
|---|---|---|
| President | **F. B. Plumber**, The University of Texas | 132 |
| | O. A. Ullrich, Southwestern University | 65 |
| Executive Vice-President | W. T. Chambers, S. F. Austin State Teachers College | 61 |
| | **S. R. Warner**, Sam Houston State Teachers College | 129 |
| Section I Vice-President | C. P. Boner, The University of Texas | 85 |
| | **W. T. Gooch**, Baylor University | 104 |
| Section II Vice-President | **G. E. Potter**, A. and M. College | 139 |
| | R. G. Upton, S. F. Austin State Teachers College | 56 |
| Section III Vice-President | **O. R. Nielsen**, Texas College of Arts & Industries | 103 |
| | Gordon Worley, Sr., State Dept. of Education | 85 |
| Section IV Vice-President | Harold Vance, A. and M. College | 76 |
| | **Paul Weaver**, Gulf Oil Company | 114 |
| Section V Vice-President | D. W. Lay, Game, Fish, and Oyster Commission | 70 |
| | **V. H. Schoffelmayer**, Dallas Morning News | 120 |
| Secretary | **Cornelia M. Smith**, Baylor University | 170 |
| Assistant Secretary | J. K. G. Silvey, North Texas State Teachers College | 93 |
| | **G. B. Wolcott**, Southwestern University | 96 |
| Editor | **C. R. Granberry**, The University of Texas | 168 |
| Member of the Board of Directors | C. A. Nichols, Southern Methodist University | 91 |
| | **T. S. Painter**, The University of Texas | 103 |

Respectfully submitted,

W. R. WOOLRICH, *Chairman*
F. A. BURT
E. P. CHEATUM
E. W. SCHUHMAN
G. B. WOLCOTT
S. STOKER
H. P. BYBEE
J. G. BURR.

November 6, 1945.

## REPORT OF THE MEMBERSHIP COMMITTEE

The Chairman of your Membership Committee was authorized to select such additional members to the Committee as he might need. Because of the restrictions on travel, the following plan was adopted: In March, a letter was written to an Academy member in each Junior College, Senior College, and University in Texas requesting him to serve as a representative of the Membership Committee for his Institution. In Institutions in which the Academy had no resident member, the Dean or President was asked to refer the letter to one of his science teachers. Application blanks for membership were inclosed in the letter.

A second letter was sent to the same persons about three weeks ago thinking them for their cooperation and urging them to make further efforts in securing new members and in getting renewals of old members.

The Chairman has been unable to gauge the results of his efforts because most of the applications were sent directly to the Secretary or Treasurer. Reference is therefore made to the reports of the Secretary and Treasurer, who have accurate counts of new members and of renewals.

Respectfully submitted,
OSCAR A. ULLRICH, *Chairman*,
Membership Committee.

## REPORT OF THE COMMITTEE ON REGIONAL MEETINGS

The South Texas Branch of the Texas Academy of Science was held in Corpus Christi Junior College Auditorium on Saturday, April 14. Dr. W. Armstrong Price represented the President and Dr. Gordon Gunter, the Vice-President of Section I.

Seventeen papers were presented. It was attended by approximately thirty members and one hundred guests. The sessions were very instructive and the meeting carefully planned and successful.

Respectfully submitted,
W. R. WOOLRICH, *Chairman* of Regional Sessions.

## REPORT OF ACADEMY REPRESENTATIVE TO A.A.A.S.

To the President and Members:

There has been no A.A.A.S. meeting or Academy conference held since the one held in Cleveland September 11 to 16, 1944 and already reported at our last meeting in Galveston. Neither has there been a council meeting called. Little has been done by mail.

Your association has been active in support of legislation such as the Scientific and Technological Manpower Bill, also the bills affecting Scientific Research which is now pending.

Each member has received a prospectus explaining the need of this association for a permanent home. The prospects are good for a permanent home for A.A.A.S. in Washington, D. C.

I am sure that the good news is out there will be a meeting of A.A.A.S. next March in St. Louis.

DON O. BAIRD,
Sam Houston State Teachers College,
Huntsville, Texas,
*Representative to A.A.A.S.*

## REPORT OF COMMITTEE ON FELLOWS AND HONORS

President W. P. Taylor
Dear Sir:

Your special Committee on Fellows and Honors begs to report as follows:

We have examined the list of members of the Society with the view of selecting from among them those eligible for advancement to Fellows. The membership list at our disposal was for the year 1942.

From this list we have taken the following names:

Albers, Dr. C. D.
Albritton, Dr. Claude C. Jr.
Bodemann, Dr. Elsie
Clarence, Sister Mary
Clark, Dr. W. H.
De Ford, Ronald K.
Ellsworth, Dr. J. O.
Floyd, Miss Willie Mae
Gary, Thacker
Gary, Nawona Taylor
Giesecke, Dr. F. E.
Kornfeld, M. M.
Lee, Dr. Humphrey
Le Vesconte, Dr. Amy
Monnig, Oscar D.
Morrow, Dr. Marie B.
Rosene, Dr. Hilda F.
Scoular, Dr. Florence I.
Thein, Dr. Louis P.
Tidwell, Dr. Herbert C.
Toole, Marion
Umstattd, Dr. J. G.
Underwood, Dr. R. S.
Vance, Harold
Walvoord, Dr. Anthony
Warner, Dr. R. W.
Weekes, Donald F.
Weaver, Paul
Waggoner, Dr. Robert

We believe these persons to be qualified as Fellows.

For election as Honorary Life Fellows the committee desires to propose the names of W. J. Battle, University of Texas; F. A. Burt, A. & M. College and Wallace Pratt, Standard Oil Company.

Respectfully submitted,
E. H. SELLARDS, *Chairman*
PAUL C. WITT
C. S. SMITH
GORDON GUNTER
C. A. NICHOLS
F. B. PLUMMER
G. E. POTTER.

## REPORT OF PUBLICITY COMMITTEE FOR 1945

Mr. L. T. Murray, Secretary
Texas Academy of Science, Waco, Texas
Dear Mr. Murray:

During the year I have repeatedly alluded to the Texas Academy of Science and to science in general in my radio broadcasts over WFAA Saturday mornings 7:10 a.m. and in my writings which appeared in The Dallas Morning News in an effort to acquaint Texas with the wonderful group of scientists it has in its state institutions as well as in private industry and otherwise.

In preparation for the Annual State Meeting November 8, 9, and 10 at Waco I gave to the Associated Press two releases in which I featured the outstanding numbers on the program. This was handed direct to Mr. Frank King, chief of the Associated Press Bureau in Dallas for publication in all the Associated Press papers in the State and the Southwest. Probably for lack of space this report did not receive the use it otherwise might have enjoyed had paper in newspaper offices been as plentiful as normally.

On Saturday a large part of my address will be devoted to a report on the Annual Convention of the Texas Academy of Science and the benefits derived therefrom by industry and the public in general.

You may rest assured that at all times have I tried my best to promote science as overyone who knows me by now must recognize. It is one of the hardest jobs any one can undertake because of the indifference of the public except to the sensational which comes out of laboratories not so much as the constructive and useful.

Cordially,
VICTOR H. SCHOFFELMAYER,
*Agriculture-Science Editor*
The Dallas News.

## REPORT ON THE COLLEGIATE DIVISION FOR 1944-1945

The Collegiate Division held a series of successful meetings during the annual meeting of the Academy at Waco. The student members showed unusual enthusiasm. A business session was held Friday at 11 A.M., a scientific session at 1 P.M. Friday, and a combined session at 8:30 A.M. Saturday. Twelve papers were presented at the scientific sessions. The attendance averaged about 45. Students from nine colleges and universities were present.

At the business sessions it was voted to submit the following proposals to the proper Academy committees for action: 1. That the name of the group be changed from "Collegiate Division" to "Collegiate Academy," 2. That papers judged by members of the Collegiate Division Committee and the editor of the *Proceedings and Transactions* as worthy of publication in this journal be published, the papers to be abstracted or edited so as to occupy no more than two printed pages each, and 3. That if possible the Academy increase the Collegiate Division budget from $50 to $100 in order that an expansion program could be carried out and that a monthly mimeographed publication for the Division might be issued. Preliminary plans for this publication were made, and the name *Tasca* was selected for it, the name being composed of the initials of the title "Texas Academy of Science, Collegiate Academy." Publication will be supervised by the counselor, and each month a different affiliated club will edit an issue. It will contain news notes and papers presented at the meetings, as well as suggestions for improvements in science clubs. One purpose of the publication is to maintain interest between meetings, and another to create interest in schools not now having affiliated clubs.

The officers for the past year were Helen Auge, Incarnate Word College, President; Gene Hinds, Abilene, Vice-President; Patricia Dwyer, Incarnate Word College, Secretary; and Dr. Fred A. Barkley, University of Texas, Counselor. Since Dr. Barkley was out of the state most of the year, Dr. C. C. Doak of Texas A. & M., who had served as counselor for several years, continued as acting counselor during the year. The new officers are as follows: Betty Jo Pierce, Hardin-Simmons, President; Mary Curry, Mary Hardin Baylor, Vice-President; Alda Gianotte, Our Lady of the Lake, Secretary; and Dr. Fred A. Barkley, Counselor.

The Collegiate Division Committee held one meeting at which plans for the coming year were discussed and the application of the Science Club of Hardin-Simmons University for affiliation was approved. Sr. Joseph Marie was recommended as the new member of the committee, for the three year term expiring in 1948. Mrs. Don O. Baird resigned, and Dr. Don O. Baird was recommended to take over her term expiring in 1947. Dr. Amie LeVesconte was elected chairman for the coming year. Both the committee and the Division voiced their appreciation of the excellent work Dr. C. C. Doak has done the past several years for the Division.

VICTOR A. GREULACH, *Chairman*
Collegiate Division Committee.

## REPORT OF THE COMMITTEE ON LOCAL ARRANGEMENTS

The committee was subdivided into special groups as indicated below and each functioned to promote the success of the meeting.

The registration receipts were $59.75 and these were expended as follows:

| | |
|---|---|
| Printing programs 1200 | $37.50 |
| Express on programs to College Station for distribution | .53 |
| Printing registration badges | 2.75 |
| Sign place cards and notices | 2.50 |
| Hotel bill of Dr. Murray, secretary | 7.33 |
| Balance applied on expense of reception and tea | 9.14 |
| | $59.75 |

The local arrangements committees were as follows:

Program: W. R. Stephens, Chairman, P. A. Glick, M. L. Goetting.
Meeting rooms and projection equipment: A. W. Smith, Chairman, M. L. Goetting, S. R. Block.
Entertainment: T. J. Bond, Chairman, W. Goodrich Jones, G. H. West.

Publicity: A. M. Winchester, Chairman, W. L. Crosthwaite, A. W. Smith.
Registration: Cornelia M. Smith, G. H. West, P. A. Glick.
Membership: S. R. Spenser, Chairman, Cornelia M. Smith, W. R. Stephens.
Collegiate Division: M. L. Goetting, Chairman, T. J. Bond, G. H. West.
Junior Academy: T. J. Bond.
Tea: Cornelia M. Smith, Chairman, Mrs. W. R. Stephens, Mr. W. T. Gooch, Miss Gladys Allen, Mrs. T. J. Bond, Mrs. A. W. Smith, Mrs. A. M. Winchester, Mrs. M. L. Goetting, Mrs. Joe Clark.

Respectfully submitted,
W. T. GOOCH, *Chairman.*

## REPORT ON H. C. OBERHOLSER MANUSCRIPT ON TEXAS BIRDS

I. Pursuant to request of President Taylor following the recommendation of Irby Davis, Academy member from Harlingen and bird expert in the Lower Rio Grande Valley, the undersigned wrote to Prof. Oberholser asking him to will his manuscript to the Academy and inquiring as to the status of Dr. Donald Day's tentative offer to investigate the manuscript with a view to the University Press of Dallas, Texas, underwriting and publishing the volumes. The probable cost would be in the neighborhood of $25,000 to $50,000 or more.

II. A reply from Prof. Oberholser, now Curator of Ornithology, Cleveland Museum of Natural History, Cleveland, Ohio, states that the manuscript is the property of the Fish and Wildlife Service, Dept. of Interior. That he is working on a copy to keep it up to date. Therefore the manuscript is available for publication by the Academy or by anyone that is interested in it, but that it obviously cannot be willed to the Academy.

III. Prof. Oberholser states that no negotiations with Dr. Day have ever been commenced.

Respectfully submitted,
W. ARMSTRONG PRICE.

## NECROLOGY—1944-1945

Seven of the members of the Texas Academy of Science died during the past year, and we wish to express our sincere sympathy to their families, relatives and friends. May Almighty God be kind to them and grant each one eternal peace.

Hesse, Curtis J., Treasurer of the Texas Academy of Science at the time of his death, May 12, 1945, was born September 28, 1905, in Wamego, Kansas. He received his Bachelor of Arts degree 1927 from the University of Kansas, and his Masters Degree from the University of California in 1933. In 1938 Mr. Hesse came to Texas A. & M. as assistant curator of the Museum and in 1943 he was made curator, which position he held until his untimely death. He was Secretary of Texas A. & M. Chapter of American Association of Texas Professors, Treasurer of Texas Academy of Science, membership in Amer. Assoc. of Petroleum Geologists, in American Association for Advancement of Science, in Geological Society of America, in American Society of Vertebrate Paleontologists, also in Texas Archaeological Society, American Society of Mammalogists, in American Society of Economic Paleontologists and Mineralogists. He is survived by his mother and a brother.

Cuyler, Robert H., Captain in the Army Air Force, and associate professor of geology at the University of Texas, was killed in an airplane accident near Blanco, Texas on March 13, 1944. He was born in Austin, Texas, on May 28, 1908, received his B.A. degree in 1926, Masters degree in 1927 and his Doctors degree in 1931 from the University of Texas. He was appointed instructor in the department of geology in 1927, assistant professor in 1935 and in 1939 he was promoted to an associate professorship. He was a member of Sigma Gamma Epsilon, a Fellow of the Geological Society of America, he was also a member of the Paleontological Society, Society of Economic Paleontologists and Mineralogists, Southwestern Geological Society, American Association of Petroleum Geologists and the Texas Academy of Science. He is survived by his wife, Dr. Esther S. Cuyler, and an infant son, Robert Hamilton, Jr., by his mother, Mrs. Sarah Cuyler, one sister, Dr. Iona Hamlet of Fort Wayne, Indiana, and one brother, Dr. William Cuyler, Duke University, Durham, North Carolina.

Sinclair, John F., Department of Biology, Colloge of Arts and Industries, Kingsville, died December 10, 1944. He was a Life Member of the Academy. He has served as Vice-President of Section III, in 1930-31; Chairman of the Resolution Committee, 1929; Member of the Nominating Committee, 1929; and the Auditing Committee, 1930. He is survived by his widow, three daughters, and four granddaughters.

*Wisely, J. H., head of the Department of Business and Manager of Stephen F. Austin Teachers College, died May 26, 1945.

*Bond, John Henry, San Antonio—Letter returned to Secretary marked "Deceased".

*Scruggs, Eugene A., Collegiate Division 1943-1944, Abilene Christian College, killed in action in Germany, April 1, 1945.

*Sewell, Mrs. J. P., San Antonio—Died May 18, 1944.

Signed,

FATHER FRANK J. O'HARA, S. C. S.

*These four members were recently added to our list. Complete details will be entered and given to the editor.

## ANNUAL REPORT FOR SECTION I

To the President,
Texas Academy of Science.

During the year only a limited amount of activity in the interest of the Academy was engaged in. There were no sectional meetings held prior to the general session in Waco.

The membership of the Section was circularized to spread information and to build a program of the Section to be presented at the annual session of the Academy in Waco. A program was prepared consisting of four papers all of which were presented as scheduled, ably and interestingly delivered. For the titles and authors of the papers reference to the general program should be made.

The Chairman also engaged himself in solicitation of new members. The net results were ten members for Section I, and one member for Section II.

The Chairman desires to offer the following suggestions:

1. It appears very advisable that the Collegiate Section of the Academy should be promoted more vigorously now than ever before. The depleted ranks of young scientists because of the war will produce a serious gap in the recruits to our membership in the immediate future. It is from this source that we must draw our support.
2. Increased efforts should be made to effect a program of research under the direction and sponsorship of the Academy. Grants-in-aid, fellowships, etc., should be sought and secured as soon as possible.
3. As rapidly and as fully as practicable younger members of the Academy should be placed in official capacities. This policy would lead to increased interest in the welfare and services of the Academy as well as the encouragement of young scientists.

Respectfully submitted,
W. R. STEPHENS,
*Vice President and*
*Chairman of Section I.*

## ANNUAL REPORT FOR SECTION II

Dr. W. P. Taylor, President
Texas Academy of Science
College Station, Texas.

Dear Dr. Taylor:

The Academy held its 1944 meeting in Galveston as guests of the Medical Branch of the University of Texas.

The program was one of the best the Academy has seen and the attendance was excellent. A total of 81 papers was given of which the biological section had the lion's share.

One of the symposia dealing with Conditions of Health on the Texas Coast was outstanding in its practical value. It was received very indifferently by the community at first but the ideas which were included have begun to bear fruit in many ways during the year. The entire effort would have been of incalculably greater value if we had been able to see prompt publication of the papers.

The symposium of Biology of the Cancer Cell was an excellent series of papers but its value is largely lost because no abstracts or papers were given to us to print.

There was very little activity during the year until we began preparations for the Waco meeting. I had presented a series of recommendations for improving the collection of programs by having institutional representatives. Nothing came of the suggestions so the alternative was to attempt to carry out the idea within the biological section.

I started out by sending 26 letters to selected men in all the educational institutions in the state which were listed among the approved colleges of arts and sciences by the AMA. I asked these men to serve in their institutions as representatives of the Academy for the purpose of getting program material for all sections.

Later I sent out over 200 printed postcards to members who were or had been interested in the Biological Section. I indicated the need of abstracts, the publication of papers by members etc. Since the form may be useful I copy it here.

THE TEXAS ACADEMY OF SCIENCE

> The next annual meeting of the Adamey will be held in Waco Nov. 8, 9, 10, 1945, as guests of Baylor University. Papers are solicited from members and other interested scientists. Papers by members may be submitted in full for publication in the Transactions. Contributors may become members at the time of the meeting. Abstracts of all papers are to be sent to the sectional vice-presidents not later than Oct. 10, 1945 if the title is to appear on the printed program. Submission of complete manuscript in good form for publication aids the editor and expedites publication.
>
> Cordially yours
> JOHN G. SINCLAIR
> Medical Branch, U. of T.
> Biological Section. Galveston, Texas

As titles and abstracts came in I sent a card to each contributor telling where he would appear in the program and forwarding the title to the general program chairman. On Oct. 11, I made up the program schedule of sessions and forwarded it for printing.

The result is that of the 67 papers for the Academy over 30 are in the biological section. Even this does not begin to include work going forward in Texas that should be reported. Many schools have no representatives at all. Fortunately the medical schools are becoming interested and are contributing heavily.

As I see it the most important thing this Academy can do is to relieve the editor of the job of getting funds to publish his transactions and then get the transactions out at once. As we go along I believe we should insist on an abstract in proper form before printing a title in the program. We should print all abstracts of papers presented. We should print full papers only of members but invite the speakers to join at the time of the meeting.

Cordially yours,
JOHN G. SINCLAIR, *Vice President, Section II.*

## ANNUAL REPORT FOR SECTION IV

Dr. Walter P. Taylor, President
Texas Academy of Science
Box 254 Faculty Exchange
College Station, Texas

Dear Dr. Taylor:

I herewith submit a report on the activities of Section IV, Geography and Geology, of the Texas Academy of Science:

The chief work of this Section has been in connection with preparing a program for the annual meeting. It was our plan to present a symposium on the natural resources of Texas; we were able to secure a rather complete set of papers, but were unable to secure a paper on solid fuel resources of Texas even though a number of qualified individuals were solicited. This subject is of considerable importance at this time, due to the controversy concerning the out-of-state shipments of natural gas. The public should be informed as to what other fuels are available in Texas besides oil and gas, and what fuels we may depend upon here when our oil and gas have been exhausted.

It was necessary to turn down a number of papers on geology and related subjects submitted by members of the Academy, because the writer scheduled only one afternoon session. The writer assumes full responsibility in not being foresighted enough to anticipate papers covering general geological subjects to be submitted voluntarily by members. It is hoped that the next vice-president in charge of this Section may profit by the writer's experience.

Yours very truly,
HAROLD VANCE, *Vice-President*
*Section IV, Geography and Geology.*

## THE TEXAS ACADEMY OF SCIENCE
## JUNIOR DIVISION

Science Building, Baylor University, Waco, Texas
November 10, 1945

Miss Greta Oppe, *Chairman*, presiding

I. Annual Meeting of Junior Academy Committee and sponsors. (Detailed report appears in this section.)

II. Junior Program.
   1. *Penicillin.* Bill Lastinger and Lawrence Martin, Austin.
   2. *Factors Which Affect Bacterial Growth.* Gwynne Gibson, Jean Pafford, and Rulene McPherson, Austin High School.
   3. *The Construction of a Telescopic Mirror.* Al Schroeder, Abilene High School.
   4. *A Study of Nebulae.* Don Griffis, Ball High School, Galveston.
   5. *Studies in Microtechnique.* Joe Adamcik, Austin High School.
   6. *Therapy by Atomic Fission.* Brantly Harris, Galveston.

7. *Native Plants in Your Aquarium.* Norman Heard, Austin.
8. *Thiokol Rubber.* G. C. Gaeke, Lamar High School, Houston.
9. *Hypnotism.* Dan Grieder, Austin High School.
10. *The Flying Wing.* Dickey White, Abilene.
11. *The Antiquity of Man in North America.* Charles Kallenkamp, Lamar High School, Houston.
12. *Dimensions in Relation to Reality.* Joe Baldwin, Jr., Lamar High School, Houston.
13. *A Study of Relativity.* Melvin Schreiber, Galveston.
14. *The Gas Turbine.* Ulrich Merten, Lamar High School.
15. *Embalming.* Charles Tandy, Abilene High School.
16. *The Avocado.* Wentz Fehrenbach, Brownsville High School.
17. *The Saw Beetle.* Richard Graham, Brownsville High School.
18. *Snakes.* Lawrence Curtis of Highland Park High School, Dallas, formerly of Ball High School, Galveston.
19. *The Papilionidae of Harris County.* Carl Pitschmann, Lamar High School, Houston.

## REPORT OF MEETING OF THE JUNIOR ACADEMY COMMITTEE FOR 1945

Sponsors present: Greta Oppe, Chairman, Galveston; Edna Miner, Secretary, Houston; Mrs. Collier, Abilene; Velma Wilson, Brownsville.

Visitors present: Dr. L. W. Blau, Dr. G. P. Parker.

Members of Junior Academy Committee whose terms expire or who resigned are:

Addison Lee (1945) Austin High School. Re-elected (1948).

Genelia Lewis (1947) resigned to accept college position at TSCW, succeeded by Mrs. Jeanne Felber, Goose Creek.

Miss Velma Wilson of Brownsville Junior College was elected secretary-treasurer to succeed Mrs. Edna Miner, who, however, will retain her position on the committee as regional director.

The Academy committee sent an expression of sympathy to Dr. Emily Barry Walker, now of Nashville, Tenn., who lost her father recently. An expression of appreciation went to Dr. Taylor, President of the Academy, and to Mr. T. J. Bond, who acted as local chairman from Baylor University.

*AAAS award:*

Girl: Kathleen Garrett, Ball High School, Galveston, Texas, only girl recommended.

Boy: Robert Felix, Ball High School, Galveston, Texas, now of Oberlin College, for his work on *Tissue Culture Techniques.*

Respectfully submitted,
GRETA OPPE, *Chairman.*

# REPORT OF THE TEXAS JUNIOR ACADEMY OF SCIENCE FOR 1945

The Junior Division of the Texas Academy of Science held its annual meeting at the University of Texas School of Medicine in Galveston, November 11, 1944. A meeting of the sponsors and the Junior Academy Committee preceded the Junior program. Five chapter sponsors responded: Mrs. Mike O'Neill, Ornithology Club, Commerce; Mrs. Edna Miner, Lamar Chapter, Houston; Miss Helen Boysen, Raymond Ditmars, Austin; Miss Louise Loomis, Big Thicket Science Club, Sour Lake, and Miss Greta Oppe, general chairman and sponsor of the Galveston chapter.

The Academy Committee for the year 1945-46 with the date of expiration of their terms of office are:

Chairman, Greta Oppe, Ball High School, Galveston.
Secretary-Treas., Mrs. Edna Miner, Lamar High School, Houston.
Velma Wilson, Brownsville Junior College, 1946.
Willie Mae Floyd, Abilene High School, 1947.
Genelia Lewis, Denton High School, 1947.
Addison Lee, Austin High School, 1945.
Dr. Leo T. Murray, Academy Secretary.

Forty-five Juniors attended their session and twenty-six visitors. The program follows:

*Junior Academy Program.* 10:00 A.M., Dick Morrison, Galveston, presiding.

1. The Canti Tissue Culture Film. Dr. Thurlo Thomas, U. of Texas Medical School.
2. Demonstration of cutting and mounting tissue sections. James Pratley and Robert Felix, Ball High School, Galveston.
3. The quick preparation of free-hand sections. Ruth Sinclair, Ball High School, Galveston.
4. Turtles of the Houston Area. G. C. Gaeke, Houston.
5. Sphinx Moths of Harris County. Walter Abbott, Houston.
6. Collecting moths and butterflies as a hobby. Carl Pitschman, Houston.
7. Importance of Fossils and the Geology of the Cretaceous of Central Texas. Ernest Lundelius, Austin High School.
8. Experimenting with rocket propulsion. Ulrich Merton, Houston.
9. Fox fire and luminescent wood. Edwin White, Sour Lake.
10. Observations of ant lions. Jim Richardson, Houston.
11. Experiences of an amateur herpetologist. Billy Milstead, Houston.
12. Crossing papayas. Betty Williamson, Brownsville.

A luncheon at Hill's Cafe sponsored by the Ball High School Chapter concluded the session.

Students receiving the AAAS award were: Billy Milstead, Lamar Chapter, Houston; Betty Williamson, Brownsville; Dorcas Sugars, Galveston, honorable mention.

There were thirteen chapters affiliated with the Junior Division at the close of the school year, June, 1945. Prior to the opening of school in September, a circular letter was sent to all chapters whose membership had lapsed and to clubs affiliated with SCA. There are now sixteen chapters and thirteen more clubs have asked for information, including one negro high school in Dallas.

The chairman cooperated with Dr. John W. Thomson, Jr., Assistant Professor of Botany, University of Wisconsin, in the organization of the Junior Academy Division of the Wisconsin Academy of Science. The Chairman also contributed an article, "Activities for Texas Youth," in the August issue of the *Texas Outlook*. Three issues of *Tex-Sciana* were distributed and all affiliated clubs received free subscriptions to *Texas Game and Fish*.

The Junior Division is exceedingly grateful to the President of the Texas Academy of Science, Dr. Walter P. Taylor, for his loyal support and regrets the loss of the Academy Secretary, Dr. Curtis J. Hesse, who died May 12, 1945.

This report reflects the fact that during the critical years of World War II, the Junior Division continued its activities. To students and teachers who made this possible, the chairman expresses her thanks.

Respectfully submitted,
GRETA OPPE, *General Chairman*
Ball High School, Galveston, Texas,
November 10, 1945.

## JUNIOR ACADEMY DIVISION TREASURER'S REPORT FOR 1945

| | | |
|---|---|---|
| Balance on hand, November 3, 1944 | | $ 29.22 |
| **Receipts:** | | |
| 1. From Dr. Hesse, Academy Treasurer | $ 35.00 | |
| 2. 1944-1945 dues, 11 x $2.00 | 22.00 | |
| 3. 1945-1946 dues, 5 x $2.00 (Galveston, Houston, Floresville, Brownsville, and Abilene) | 10.00 | 67.00 |
| | | $ 96.22 |
| **Disbursements:** | | |
| 1. To Abilene for Texsciana | $ 16.95 | |
| 2. To Houston for Texsciana | 7.50 | |
| 3. Postage to the treasurer | 3.00 | |
| 4. Game, Fish and Oyster Commissioner, 13 subscriptions at $0.50 | 6.50 | |
| | | 33.45 |
| Balance on hand, $96.22 minus $33.45 | | $ 62.77 |

This money is deposited in the City National Bank of Houston. As near as I know, this accounts for all the money received and spent.

Respectfully submitted,
EDNA WOLF MINER, *Secretary-Treasurer.*

# TRANSACTIONS

# Endless Frontiers in Texas

## PRESIDENTIAL ADDRESS

WALTER P. TAYLOR
College Station, Texas

Thoughtful persons everywhere are becoming increasingly interested in the conservation of wildlife, waters, forest, forage on the grazing ranges, soils, and minerals. Tonight I want to emphasize one aspect of the conservation program which is more important than all the others put together. I refer to the conservation of human beings. The subject is so vast that I must limit it, for purposes of this discussion, to the problem of the conservation of the intellectual workers, the group represented in Texas, among other organizations, by the Texas Academy of Science. Said a great Texan, Mirabeau B. Lamar, "The cultivated mind is the guardian genius of democracy." More recently President Sproul of the University of California has written, "The intelligence of the citizenry of a nation is a natural resource which transcends in importance all other natural resources. One may condone the waste of many natural resources on the ground that science will some day discover a substitute that is just as good. But intelligence is quite unique, and though science search diligently it will never find a substitute for it."

It is perfectly obvious that the successful perpetuation of human resources of every sort, in Texas or elsewhere, depends in large measure on the conservation of our basic natural resources. For without fertile soils, adequate supplies of wood, pure water, feed for livestock, well-balanced animal populations (both wild and domestic), and abundant minerals (perhaps most important among them coal, iron, gas, and petroleum), there can be no proper human resources, nor for that matter any adequate intellectual resources. Thus we have a beneficent circle. The conservation of the basic natural resources depends on man, and in turn, man depends on the proper conservation of the natural resources. A high standard of living obviously depends on the proper functioning of the entire circle.

### SOME OF THE ENDLESS FRONTIERS

I have had the good fortune recently to do some official work in the Big Bend National Park. Even in this great area, sometimes referred to as the last great frontier in Texas, we no longer have the pioneer conditions which offered so much of exhilaration, economic promise, and adventure to our predecessors.

But if our frontiers of plain and desert and mountain have been largely eliminated, there are other frontiers that are well-nigh limitless. Let us run down the list of some of these:

Frontiers of exploration and control of the wasting diseases that still afflict us.

Frontiers in the struggle against premature old age, as pointed out recently by Shaply (American Scientist, Vol. 33, No. 2, pp. 84-102, Spring Number, 1945). We are all too familiar with some of the enemies to be encountered on this frontier—cancer, tuberculosis, heart trouble, arthritis, nephritis, the various neuroses.

Frontiers in combatting the appalling ignorance and even illiteracy which are all too obvious in our population.

Frontiers in the "happy fight" against chain-thinking, mental goose-stepping, cultural uniformity, deadening centralized manipulation of the minds and mores of the people, to quote Shaply again. These things, so likely to result from our nation-wide radio, newspaper, and movie chains, tend to a dangerous deadening of individuality and of local values. To combat these we should encourage original community craftsmanship, local science clubs, symphony orchestras, folk-singing, folk-lore groups, community dramatics, home-town radio programs, original and local ideas and movements. No state is richer in the possibilities of all these things than our own Texas.

Frontiers in the fight against the tyranny of the unknown. Even the Director of the Harvard College Observatory, who, perhaps has seen as far into the unknown as any other human being, points out, "We are still embedded in abysmal ignorance of the world in which we live". We should join, he thinks, in a methodical and elaborate warfare on the Tyranny of the Unknown. We have got over being afraid of strange squeaks in the dark, (for a priceless discussion of all this see Shaply's paper just cited), but we still blunder about in a world about which we know so very, very little.

Frontiers in the development of better racial and cultural relations with persons of different skin color living among us, and of different social heritage living beyond our borders.

Frontiers in promoting the public welfare with all that means in extermination of poverty and the provision of full employment.

Frontiers in the more effective use of our still vast enterprises of primary production, including shoreline and marine resources, agriculture, and mining.

Frontiers in building great processing and service industries, so that we may move onward with the other progressive forces in the South and throughout the Nation toward the sustained and balanced prosperity which should rightfully be ours.

These and similar frontiers are endless. We must range ourselves in the forefront of explorers of these new and unknown regions. We can only do this if we keep on the job of research, of teaching, of training the best obtainable intellectual workers and leaders. We must not let all our ablest sons and daughters leave us. We must bring in the best we can get from outside.

### AMERICA'S GREATEST WARTIME MISTAKE

America's greatest wartime mistake was not the handling of the Japanese on the Pacific Coast, although I agree with those who feel that our treatment of these aliens and citizens was far from enlightened.

Unquestionably our greatest wartime mistake was in wasting of our scientific men, especially our young scientists. It will be remembered that effective and timely protests on this score were made on several occasions during the war by Dean W. R. Woolrich, your presiding officer tonight. Furthermore, in his Presidential Address to the Texas Academy of Science at Galveston last year, Dean Woolrich called pointed attention to the fact that a large number of the basic inventions in the field of engineering are from the creative works of very young men.

During a recent debate on the May Bill authorizing an annual appropriation of $8,000,000 to the National Academy of Sciences for a permanent program of post-war military and naval research in technical and scientific fields, Congressman McDonough of California urged the exemption of scientists and other key personnel from the draft, pointing out that the United States is the *only nation* that has failed to provide adequate safeguards against the loss of needed chemists, engineers, physicists, and other highly skilled personnel. It should be mentioned that the case is even worse in the biological sciences.

Unfortunately the damage is done, and we will gain nothing by useless repining. But maybe by taking thought we can avoid such a suicidal policy in the future.

You will remember that in a recent column Wiggam raised the question, "Will scientists make as many new discoveries and inventions after the war as before and during the war?" Do you remember the answer? It was definitely no for six reasons: (1) Many scientists have been killed, (2) many of our most brilliant young men—future scientists—have been killed, (3) thousands who would normally have gone into science have been shifted into other careers, (4) thousands who had planned to take up science feel now they must take the first job available, (5) the normal supply of young men coming from colleges into science laboratories has been stopped for four years, (6) war does not cause new scientific discoveries. It mainly speeds up applying discoveries already made. Research is killed by war.

Let us go further and review the answer to this question by M. H. Trytten, Director of the Office of Scientific Personnel of the National Research Council, who discusses the impending scarcity of scientific men (Scientific Monthly, Vol. 60, No. 1, pp. 37-47, January, 1945).

Technological know-how, Trytten points out, the know-how that won the war, is the result of training. During the war the training ceased, particularly at the highest and most vital level. ". . . we . . . actually followed policies whose effects must be to weaken our technology for years." Obviously, persons of highly specialized training are of first importance. Never numerous, they are always supremely significant. In these technical times a Meitner may be worth half a dozen armies.

Graphs of the number of doctoral degrees granted since 1913 show a marked decline at the beginning of the war.

"The deficit of science and technology students who, but for the war, would have received bachelor's degrees is about 150,000. It is estimated that the deficit of those obtaining advanced degrees in these fields will amount in 1955 to about 17,000 for it takes at least six years from college entry to achieve a doctor's degree or its equivalent in science or engineering." So says Vannevar Bush, Director of the Office of Science and Research Development (Science, Vol. 102, No. 2639, p. 80, July 27, 1945). "The real ceiling on our productivity of new scientific knowledge and its application in the war against disease, and the development of new products and new industries, is the number of trained scientists available." Trytten points out that the first necessity for an expanding technology is a steady flow of trained personnel. The same thing is true of an expanding exploration and development in all the frontiers of science.

"National security", it is pointed out, "both from the military and industrial point of view, will demand many more people than we have trained, largely because of our lack of sensible policy during the war."

We ought to recognize that it is unnecessary, in order to demonstrate our democracy, to send our intellectual workers to combat, to destroy the most effective defense assets of our people, namely, their brains, their intellectual resources.

There is a big job ahead in education. Let me quote from the New Republic (Vol. 113, No. 10, p. 286, September 3, 1945):

"The recent terrifying article in the SATURDAY EVENING POST called 'The GI's Reject Education' should arouse the American people to the colossal educational task that lies ahead. It said that 5,000,000 members of the armed forces—almost half—have not finished grammar school. Hundreds of thousands of others had their high school and college careers interrupted—in most cases ended—by the war. Yet fewer than one percent of the discharged veterans are taking advantage of the GI Bill of Rights educational provisions." While later information indicates that the situation is not quite so extreme as this, we cannot doubt the reality of the problem.

"Of all the battles that must be fought with vigor in the next few years, none is more pressing than the battle for better trained minds. Many of our elementary and high schools have lost their best teachers during the war. Salaries have remained low, and few people have been attracted by the teaching profession. The draft is still taking the 18-year-olds—interrupting the education of thousands of our most promising citizens. As a nation, we do not seem to be alive to the terrible losses we have suffered in the education of our people."

## Are We Getting the Most Out of Our Teachers and Investigators?

Whether we happen to be teachers, investigators, college presidents, members of boards of trustees, legislators, or interested citizens on farm, or ranch, in business, the professions, or the ranks of labor, we are all interested in the most efficient and successful production of goods and services, intellectual and otherwise. Since all affected developments whether in primary production enterprises such as agriculture and mining, in industrial operations, or in the service activities *depend on efficient research to discover new facts and effective teaching to acquaint each new generation with them,* it becomes clear that the colleges occupy a central position of responsibility and opportunity in the life of the nation. But the colleges cannot properly discharge their duties of research, teaching and inspiration without great men on their faculties. "The most important single factor in scientific and technical work is the quality of personnel employed" (Bush, Science the Endless Frontier, 1945, p. 15). I therefore commend to your consideration the following suggestions for application to intellectual workers so as to make the climate of our educational and research institutions continuously more favorable to the human beings who must do the work, and so to stimulate production.

Pay standards should be increased for all grades of intellectual workers including all teachers from first grade to university, so as to secure and hold the most capable men and women in these important enterprises.

Standards of performance and service by teachers and research workers should be more rigorous than ever—but the necessary weeding out of the less capable should be done during the first year of their service rather than after many years of faithful work. Incidentally, it is only by increasing pay standards and otherwise improving conditions for work that any weeding out worthy of the name can be successful. Advantageous promotion policies and retirement benefits should also be provided, where this has not been done.

Long term signed contracts between educational institutions and teachers and research workers, in other words, permanent tenure during good behavior, following the most enlightened practices of our best American institutions, should be the rule, thus assuring to the intellectual worker a secure future and freedom from economic worry.

Effective faculty participation in college government along well-established democratic lines should be required in accordance with the best practices of the most enlightened educational institutions.

A system of generous educational leave should be arranged for so that the teacher will not get into a rut. Indeed, representative Texas teachers and research men should be detailed to attend every important gathering of brilliant minds working in their field anywhere in the world with full salaries and all expenses paid. How can our faculty members take their part in professional societies, in national and international affairs out of their present relative meager stipends and under present administrative and legislative restrictions? We should remember that only by travel and contact can obsolete ideas and methods be avoided, and up-to-date service to the people be assured. This is especially necessary if we are to keep up with the procession in these rapidly moving times. For many years Soviet Russia has sent her scientific men all over the world to pick up new ideas, become familiar with new and unusual industrial and agricultural processes, explore other countries. So successful has she been that she now bids for equality, if not supremacy, in many fields of high technical research, whether agriculture, engineering, or the biological sciences. Should Texas and America do less in these days of endless frontiers in science? But in order to do this, money must be provided, legislative restrictions on travel removed, and administrative encouragement given to our alert teachers and research workers to get out and get going.

In many Texas institutions teaching loads should be drastically reduced so that all qualified workers will be encouraged to perform research in their chosen field. It is well known that industries are doing more and more research as a business proposition. Harry L. Derby, President of the American Cyanamid and Chemical Corporation, says that in 20 years there has been a seven-fold growth of industrial research. Industrial firms now are reported to be spending $300,000,000 per year on research. It is utterly impossible to perform high-class research if one is loaded down with a heavy teaching schedule. A comparison of teaching loads in some of our Texas schools with those in comparable institutions elsewhere shows our men to be heavily handicapped. Note that a greatly increased proportion of research is being done by industry, largely for profits returned to the industry, as compared with research by the universities, colleges and federal government for the general welfare. Is this the way we want it? But where will we get the money? I don't know. It may be noted, however, that if we had made available for research but one-tenth of one per cent of the total income of Texas citizens for 1943 the figure would have been $59,282,770.00. At one percent we could have set up a research fund of $592,827,700.00. It looks like we have the money, if and when we want to use it that way.

Improved equipment should be provided for the work of teaching and research. The shortage of adequate buildings, especially classroom space, in some of our institutions is almost an educational scandal. Is our engineering and biological equipment up to date, or are we 20 years behind the times? Can we expect our intellectual servants to do their best under existing conditions? Is it safe to permit this condition to continue?

Library and museum facilities in the South should be drastically expanded. We might as well face the facts. Our collections of books, museum and research materials in Texas are for the most part pitifully inadequate. Why should not some of the greatest libraries and museums in the world, especially those dealing with southern resources and southern conditions, and further, with Latin-American problems, be in the Southern United States, and specifically in Texas? Already our great commonwealth boasts of being first in area and in many activities. Why should we not aim to be first in service in those agricultural, industrial, cultural and scholastic pursuits which are in accord with the needs and peculiar genius of our people? Do our Texas students deserve any less than this? If we grant the desirability of policies of this kind, we must favor the substantial expansion of great repositories of the cultural materials of the world, especially libraries and museums.

But with all this proper emphasis on equipment and means, let us never forget that after all the greatness of an institution resides not in the size of the campus, the architectural adequacy of the buildings, the equipment, or even the prowess of the football team, but in the great and famous men, scholars, and leaders on its faculties. Raze all the buildings, but keep the faculties, and our institutions would remain virtually intact. Although their buildings and equipment are gone, the universities in China live on.

It is the best investment in the world to spend money on good men. Many of these we have on our present faculties, but they have had all too little encouragement. All too many of our high-class teachers and research men have been tolled away from us by the advantages of work in other parts of the country. We are very much the poorer for their going. As President Conant of Harvard said recently, "We shall have rapid or slow advance in this direction or in that depending on the number of really first-class men who are engaged in the work in question." (Bush, Science the Endless Frontier, 1945, p. 18.)

Why all these expanded privileges for teachers and research workers? For the delectation and enjoyment of the individual? No! But for improved service of all the people of this great State. The professor can get along. Ordinarily he does little harm to anybody. All too often he does too little good. We want real work, work that counts, the best work in the world, done right here in Texas.

If we the people want for our children the best education, the greatest inspiration, the world can afford, if we want real progress, can we do less than to keep strong men on our faculties and provide them with the equipment to work with? No, not for the professors, these things. For all citizens, for the children of the people! For Texas and the Nation!

## NATIONAL DEFENSE

The close relationship between science and national defense is convincingly obvious. Can anyone contemplate the recent advances in engineering, including the atomic and azon bombs, atomic fission, radar, the new fields of electronics, chemurgy and such biological and medical contributions as penicillin, blood plasma, and the sulfa drugs, and doubt the intimacy of this relation between science and our future security?

Is the professor a screw-ball? Some are. So are some business men. But listen to the testimony of a realistic newspaper man on the subject of professors:

"It was the professors who turned the tide of this war—professors plus the factories which produced the airplanes, the tanks, the artillery, the ships, the radar and the atomic bombs. We had big armies in 1942. But they were fighting bare-handed or with out-of-date tanks, guns and airplanes—until the factories and the professors and the industrial geniuses of the nation got going." (Drew Pearson, Dallas *Morning News*, November 3, 1945.)

The only fear we need have of other nations, say for example

Russia, is that these other nations, through superior intelligence and insight, will build a more effective science than we can; that they will succeed in providing more jobs, additional commodities, a truer and more practical religion, a higher standard of living, sounder ideals, higher cultural standards, more adequate means and methods for successful cooperative modern living.

## CONVOYS OF CIVILIZATION

Without the convoys of many alert ships the cargoes of food and fighting materials and of fighting men travelling from America to Europe and the South Pacific could never have survived the attacks of U-boats and reached their destination. The war would have been lost and the results to humanity unthinkable.

In a real sense the colleges and universities, with their crews of intellectual workers, teachers and investigators of all grades, are the convoys of civilization. If they fail our democratic culture is done for. The universities and the university men were among the first institutions and individuals to be liquidated by Hitler and Mussolini.

Seemingly the fight for the ideals of humanity is never won. We have thought the right of Academic Freedom was well established. Were we mistaken? There is much misunderstanding of the meaning of academic freedom. To many persons academic freedom means something far off, perhaps in the cloistered halls of a monastic educational institution. Here is a dictionary definition:

Academic Freedom—"Freedom of a teacher, especially a college or university professor, to express the truth as he sees it; immunity of a teacher or professor from loss of position because of expression of individual opinions."

Academic freedom is American free enterprise in the best sense translated into the field of education and research.

Obviously this freedom to express the truth is as basic as freedom of religious faith, freedom of the press, indeed any one of the fundamental human freedoms.

A word about loyalty. This is of the highest importance. Should the scholar be loyal to his college and his university? Surely! To his church? Yes, of course! To the State? Certainly! But what of the scholar's ultimate loyalties? These are to the highest ideals of beauty, goodness and truth of which man can conceive; to the general welfare of mankind the world over; to the body of professional knowledge and to his coworkers; to God's own great principles worked out in universal applications. The scholar worthy of his salt will permit no institution, no, not the church, certainly not the State, to confuse this issue—God and ideals are higher than church or state—on this the democratic state relies. To insure the survival of democracy the people, the boards, the administrators, and faculties alike, must insist on the freedom to study and teach and act in behalf of progress wherever the truth may lead.

The leaders and investigators are no more the employees of the boards of trustees than the judges appointed by the President of the

United States are the employees of the President. Just as the judges are the judicial representatives and servants of all the people, so the intellectual workers are the educational and scientific servants of all the people.

The press rightly insists on being free to the point of being permitted to make its own mistakes. Shall we extend any lesser degree of freedom to the workers in educational and research institutions?

Does anyone think that America could have ever won the supremacy she enjoys, or, for example, that business men could have made as much money as they have made, in a country where prevailed a lesser degree of untrammeled inquiry, freedom to study and teach, than in America?

Sometimes we have taken these freedoms for granted, but we should not. Eternal vigilance is the price of the precious right to study and teach, along with the other freedoms. In possession of this freedom, there is some hope for the solution of our physical, economic, racial, educational, and philosophical problems. Without it, we approach dictatorship, totalitarianism, and disaster. Thus the issue is not one affecting university and college professors alone, but every teacher and educator, and indeed, every great corporation, every small business man, every citizen. It strikes deep into the heart of our personal and national security. Few national issues are of greater importance.

Let those who wish to maintain the *status quo* keep an eye on the colleges—for with strong, able, and intelligent men of good will on their faculties, the *status quo* is doomed in so far as it is evil. Who wants to keep it? Illiteracy, far too high, and in America; low income and widespread poverty; slums; threats of unemployment when we have proved that full employment is possible if only we are sufficiently interested in it; provincialism and complacency associated with widespread ignorance of national and world affairs; racial and religious intolerance. A physical status so low that a large proportion of the draftees had to be rejected.

In order to take our place in the new world, we must extend positive encouragement to every form of science, we must encourage all efforts to push back the clouds of ignorance, we must strive for economic democracy, we must tackle the diseases, the slums, all those things which offend and injure the human spirit. We the Victors must fight against the tendency to take over the worst traits of the vanquished—intolerance, violence, fascism.

## SCIENTIFIC RESEARCH, AN ENDLESS FRONTIER

At the Conference on Research and Regional Welfare, held at the University of North Carolina in May of this year, the question was raised, "Why is there special and immediate need for consideration of research in relation to welfare?"

The answers are so good and so cogent that I am going to review them.

1. "Research", it was pointed out, "is needed because new times call for new ideas and new practices." Unquestionably we live in a

period of drastic readjustment and change. The future will be heavily weighted in behalf of those with superior knowledge. In this connection, an utterance of Dr. David Starr Jordan's comes to mind: "Wisdom is knowing what to do next; Knowledge is knowing how to do it; and Virtue is doing it."

2. "Research is particularly needed because the changes, whatever they may be, and whether for good or bad, will be made by *people*, including ourselves." The laws of Nature do not change. Indeed mere man cannot break a law of Nature—he can merely break himself against it. After all, the people, we ourselves, are the principal problem. There's food for thought in somebody's statement that a child's worst hazard is its parents.

3. "Research is required for self-defense. We do not want to trail our neighbors and always take their dust." We need not labor the point further.

4. "Research is needed if we are to make the most of our raw materials." Peculiarly gifted is the South in many of these same raw materials; but in spite of this, we import many more of our finished products than we export. This is not as it should be.

5. "Let us not think only of physical raw materials", write the wise men from North Carolina. "We might well be concerned, also, about the extent to which we now 'export' the young folks or make it virtually necessary for so many of them to leave this region for the training that will make them expert chemists, physicists, plant pathologists, historians, physicians, government administrators, artists or musicians." "We produce young folks who want . . . high training. . . . We like such young men and young women; it would be nice to keep them about."

6. "We want research because we cannot escape paying for it." This point we often overlook. If we do not perform the necessary research so as to get the most out of our basic natural resources and to perfect our processing industries, somebody else will do it in some other part of the country. But we will pay for it in the finished product!

7. "There must be basic research." Everywhere is the need for it, in government and public administration, in the experiment stations, in the fields of fisheries and marine resources, in agriculture and engineering generally. "Underlying the whole situation is the need for more research and graduate instruction in educational institutions. It is only there that one finds the diversities of skills and the broad freedom of analysis that must be brought to bear on special problems of all sorts."

Scientific research then, is one of our endless frontiers. As we expand the circle of the known, we touch the unknown at a greater number of points.

There is another justification for scientific research, well stated by Lieutenant Trager of the Sanitary Corps writing from New Guinea to Science for October 27, 1944. He says, "The discovery and description of natural phenomena and their interrelationships are cultural activities of the highest order. In an understanding of natural science, there is a sense of beauty as definite and distinct as in the appreciation of a work of art." Why not? The works and art of Nature are the greatest in the Universe, transcending all others. Happy indeed is he who can contemplate them. Fortunate are we who are privileged to puzzle out some of the writings in Nature's infinite book of secrecy.

A distingushed member of the faculty at the University of Texas (Williams, Science, Vol. 101, No. 2630, p. 537, May 25, 1945) points out how important *research* can be in building the foundations for a healthy and expanding economic order. Charles F. Kettering has said, "If we could get out of our minds the idea that we know a lot about everything and realize that the whole thing [research] is ahead of us, then we would have a shortage of labor in no time." As Williams says, "The number of people directly concerned with research could be greatly increased, resulting in increased employment, but more important than this direct use of manpower, research creates new industries and new outlets for man's endeavors which furnish the basis for widespread employment."

These things are profoundly true, so far as they go. But it must be admitted also that technological unemployment is a very real and serious thing. Sometimes technological advances throw more people out of work than they put back to work. We have hoped this might be temporary. It seems ever more clear, now, that we may look forward to doing all the necessary work of the world in a much shorter time and with less expenditure of energy than ever before. If we are to maintain full employment and expanded income for all, this means shorter hours. And why not? Where is the peculiar virtue of working oneself to death?

## THE SOUTH IS ON THE MARCH

Let our friends, North, South, East and West take note, however, that a new spirit is moving among us. Groups of far-sighted and courageous sons and daughters of the South are appearing at widely separated localities and in no uncertain terms advocating aggressive and enlightened attack on age-old problems.

Great inspirational teachers and investigators are called to be the torch-bearers for these armies of progress.

We should not fool ourselves. It would be easy to go backward—to lose our soils, to deplete our forests and our grazing ranges, to pollute our waters, to exhaust our accessible minerals, to exterminate some of our spectacular wildlife, to become thoughtless boosters of *status quo*. Hitler recently staged a nearly world-wide demonstration that we could lose the blessings of liberty in the twinkling of an eye if we do not remain vigilant, intelligent, and strong. None of the wars against selfishness and ignorance is ever permanently won. Not for a single moment can we permit ourselves to become smug and complacent. New frontiers, endless frontiers, the most difficult frontiers we have ever tackled, make more necessary than ever intrepid exploration, fearless and unselfish organization and thoroughgoing cooperation.

Have you seen the picture story of the recent transition from sand dune to city at Tel-Aviv in Palestine in a recent March of Time? Here portrayed are the magic of science and good will.

We are living in one world. The endless frontiers of Texas have been pushed out so they embrace the entire earth. The problems of humanity are world-wide. The great human values are limited to no section or state.

If modern man proves himself unadjustable, ruggedly individualistic, prejudiced, isolationist, selfish, stubborn and dumb, he faces endless trouble and ultimate extinction. On the other hand, as beautifully stated one time by an eminent professor at the University of Chicago:

"If the devices of social invention are able to keep pace with the scientific organization of nature, the new world may be a fairyland of human achievement. The burdens of hunger, disease, toil and fears may be lifted, the book of leisure may be opened, and the treasures of human appreciation and enjoyment made available to the mass of mankind."

## GENERAL PAPERS

# DDT for the Control of Some Insects Affecting Man

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### INTRODUCTION

In the public health field DDT insecticides have proven very valuable in combatting certain insects incriminated in various human diseases and other insects troublesome to man. The insecticide is being manufactured extensively by several firms in the United States and elsewhere, and is now available to the public. Its availability will no doubt help eliminate the annoyances caused by many insects, such as, flies, mosquitoes, bedbugs, fleas and others.

DDT is a crystalline white, somewhat waxy, synthetic organic chemical compound called dichloro-diphenyl-trichloroethane. It was first synthesized by a German chemist in 1874 but was not known to be of any particular value as an insecticide until 1940 when Paul Muller, in Switzerland, discovered some of its insecticidal properties. It was patented by J. R. Geigy Company, Basle, Switzerland, March 7, 1940, and in the United States on September 7, 1943. DDT was first made available as a spray, containing 5 per cent DDT in water with a sticking agent; and as a dust, containing 3 per cent DDT. DDT is a term commonly accepted and is not a brand name used by any manufacturer or firm in describing their products.

### DDT PREPARATIONS

DDT insecticides may be classified as dusts, solutions, emulsions, and suspensions.

Dusts are prepared by grinding the DDT with inert diluents such as talc, pyrophyllite, etc. The hammer mill has been found fairly satisfactory for mixing dusts. Precautions must be taken to prevent overheating as technical grade DDT has a melting point of approximately 88°C.

Solutions are made by dissolving various percentages of DDT in solvents such as xylene, cyclohexanone, benzene, acetone, kerosene, fuel oils, etc. These mixtures are used primarily for residual sprays for the control of flies, bedbugs, for treating clothing for control of human lice, and as mosquito larvicides.

Emulsions are prepared by mixing DDT in solvents, such as xylene, in high concentrations by using an emulsifier. There are several emulsifiers on the market now that have been found satisfactory. The emulsions can be further diluted with water in order to make the percentage of DDT desired in a spray. A concentrate that is stable in water has been developed by mixing DDT and an emulsifier in a water immiscible solvent. These sprays may be used as mosquito larvicides, louse-proofing clothing, and for other insecticidal purposes.

Suspensions are made by mixing powdered DDT, to which has been added a wetting agent, and suspended in water. A mixture of DDT in talc added to soapy water has been found to mix readily. Suspensions should be kept well agitated while being sprayed.

Other preparations of DDT have been tried and merit listing. DDT has been incorporated in paints, furniture polish, and lacquers, for residual action against insects. It has also been mixed with calcimine. Preparations of DDT sticks have been developed for use against cockroaches. Aerosol bombs or dispensers containing pyrethrins, DDT, cyclohexanone, and hydrocarbon oil in Freon has been successfully used. The contents are under pressure and is released by a valve. Its uses has been for treating enclosures such as airplanes, tents, rooms, etc., for the control of insects.

## OIL SOLUTIONS OF DDT

DDT is insoluble in water but soluble in several organic materials such as benzene, cyclohexanone, xylene and others. A few of the solvents are impractical because of high cost, unavailability, fire hazard, or toxicity to humans. Solutions of DDT in oils and organic solvents are absorbed readily through the skin and must be handled with precautions to prevent contamination of the skin and of clothing with the mixtures. Five per cent DDT solution in petroleum oil may be used safely if precautions are taken to prevent excessive contact to the skin. DDT is dissolved slowly in kerosene and fuel oil and lumpy materials should be crushed and stirred into the oil while mixing. The amount of DDT that can be dissolved varies according to the solvent. The following are some of the solvents used and ranges of solubilities:

| Solvents | Grams Per 100 CC Solvent |
|---|---|
| Cyclohexanone | 100—120 |
| Xylene | 56— 62 |
| Acetone | 50 |
| Ether | 29 |
| Soybean Oil | 14 |
| Diesel Oil No. 2 | 10 |
| Cottonseed Oil | 9 |
| Kerosene (Crude) | 5— 8 |
| Kerosene (Purified) | 2— 4 |

## DDT DUSTS

There is good evidence that it is difficult to grind and mix DDT with diluent materials and it is impracticable to prepare dust mixtures without the proper equipment. The DDT is ground with such diluents as pyrophyllite or talc and is available for use against a variety of insects including household and industrial pests and certain ectoparasites of man and animals. The dust mixtures are apparently harmless to handle and a 10 per cent powder is considered safe for general use, but should not be admitted to foodstuffs. Due to the fact that there are some conflicting reports concerning the toxicity of DDT in both spray and dust form, listed below is a summary of investigations of the relations of DDT to humans conducted by Dr. Herbert O. Calvery, Chief of the Division of Pharmacology, Food and Drug Administration and by Dr. Paul A. Neal, Chief, Research Section, Division of Industrial Hygiene, U. S. Public Health Service.

1. It appears non-irritating and non-absorbent when applied directly to the skin of animals. Ten per cent dust is apparently non-injurious as used in dusting wearing apparel for killing lice.

2. When dissolved in organic solvents and oils and applied to the skin it causes some irritation. Ordinary oil solutions of DDT sprays have had no apparent toxic effects on operators over a period of several months of spraying exposures.

3. When taken internally, the reactions due to DDT, causes loss of appetite, tremors of central nervous origin, convulsions and death, but exposure to 1 to 5 per cent DDT in 10 per cent cyclohexanone with 85-95 per cent Freon, as in Aerosols, do not appear to offer serious hazards to health.

4. Even though one milligram of DDT dust per cubic yard of air space is apparently non-injurious to humans, the materials should be handled as poisonous insecticides.

5. Mixing operations should be isolated to prevent concentrations of drifts of dust and vapors within inhabited areas.

6. Operators should wear respirators and rubber gloves.

7. Avoid contacts with oil solutions of DDT.

8. Since DDT is odorless and tasteless it should be stored away from children and foodstuffs.

## INSECT CONTROL

### *Mosquitoes*

There are more than 80 known species of mosquitoes found in Texas. Almost all of these mosquitoes are pests of man while some are transmitters of human diseases. Mosquitoes are sometimes considered very difficult to control because their life histories and habits vary with the species, and control measures have to be applied to fit these variations. The best way to control the mosquito and the disease they carry is to prevent the mosquitoes from breeding. Larvicides are used for killing larva, the wigglers, while residual sprays containing DDT are used for combating the adult mosquitoes.

The percentage of DDT as residual sprays for adult mosquito control ranges from 2 to 5 per cent, applied at the rate of 10 to 400 milligrams per square foot of surface. The DDT mixed in various solvents, such as kerosene, xylene, etc., may be applied with small or large sprayers, or it may be painted on screens with a brush. It has a lasting effect from 3 weeks to 4 months. The degree of residual action will depend greatly upon the rainfall, exposures to sunlight and the dosage of DDT applied to outbuildings such as chicken houses, privies, barns, and cellars, where adult mosquitoes are commonly found resting. DDT residual sprays do not have a rapid knock-down effect on mosquitoes.

Large scale dissemination of DDT has been carried out by the use of airplanes. Except in areas such as war camps and battlefields where the health of combat soldiers are endangered, the application of DDT on a wide scale is questionable. Large area dusting of DDT effects the balance of nature among insects which is important in agriculture and wild life. The DDT kills beneficial as well as harmful insects.

For airplane spraying for control of larval mosquitoes 4 to 5 per cent DDT in kerosene or fuel oil is used. It is sprayed at the rate of .1 to .5 pound of DDT, or about one quart of spray mixture, per acre. Five to 10 per cent DDT dust is applied at the rate of 5 pounds of the dust mixture per acre or the equivalent of .25 to .5 pounds of DDT. Both sprays and dusts are applied by small hand dusters and sprayers for control of mosquito larvae in temporary water, small bodies of permanent water, and other mosquito infested places.

### *Fish*

Experiments show that mosquito larvicides containing DDT have indicated that the material is toxic to black bass, catfish and salt water minnows. Certain sprays have also shown high toxicity to goldfish.

### *Bedbugs*

Until the advent of DDT bedbug eradication was difficult and time consuming, since fumigation was the only dependable method of control. It was not only dangerous to fumigate but it required vacating the premises to be treated. If applied properly 5 per cent spray or 10 per cent powder will eliminate bedbugs and will remain effective for a few months. It is not necessary to vacate the room or house to be treated. The spray or powder is applied directly to the mattress, bed, and walls, if necessary. Wettable DDT powder may be used in a water spray if desired. Three liquid ounces of a 5 per cent spray is sufficient to treat a full size bed. It is sometimes advisable to apply the spray to baseboards and other bedbug infested places. Mattresses, pillows, springs and bedsteads should be sprayed. After a few hours of drying the bed may be made and used without fear of injury to the occupant. One and one-half ounces of 10 per cent DDT powder is sufficient for treatment of a full size bed. It is usually not necessary to treat the walls of the room with either spray or dust since the bedbugs must come to the beds for blood meals and are killed by contact of the residue of DDT on the bed. The main advantage of DDT treatment as compared with fumigation is that reinfestations are prevented for several months while only those bugs present will be eliminated by fumigation.

### *Flies*

Experiments show that 5 per cent DDT in deodorized kerosene when sprayed on to surfaces at the rate of 125 milligrams per square foot gave 100 per cent control of houseflies 158 days after treatment. Residual effect of DDT on screen wire gave a mortality of nearly 100 per cent to flies exposed 5 minutes 151 days after the screen was sprayed. The 5 per cent DDT spray gave similar results in controlling stable flies in and around dairy barns and also for flies infesting toilets and other outbuildings. Concentrations of DDT as low as 2 per cent in kerosene has proven a good control for most species of flies. One per cent DDT prepared from a stock emulsion containing benzene and an emulsifier was effective when applied to mounds of cow manure piles sprayed at the rate of 0.6 gallon per cubic foot. The action of DDT is slow and there has been some reports from laymen that it is not effective because the dead flies are not found on the area sprayed. It usually requires a few minutes after exposure of the flies to the DDT before they are killed. This allows time for the flies to leave the sprayed area before dying.

### *Fleas*

Fleas on dogs have been killed with 5 per cent DDT in pyrophyllite, dusted at the rate of 10 grams for a medium size dog. The same material will also control fleas on cats, however, the cats may be affected by the DDT since they have the habit of licking their bodies. DDT sprayed with 5 per cent strength is also successful provided the diluent used in preparing the spray is non-toxic to the animal. Dusting of rat runs with 10 per cent DDT has also been successful in controlling fleas of rats. The DDT powder is dusted on the rat runs along rafters, roof plates, exit and entrance holes, and other areas where rats are known to travel. The dust is applied with a plunger-type hand duster or with a container having a perforated lid or top. One thorough dusting is effective for three or four months. This is an important step in combating typhus since fleas transmit the rickettsiae of typhus fever from rat to rat and from rat to human.

For treating lawns, garages, outbuildings, homes, and other areas infested with fleas, a 5 per cent DDT spray or 10 per cent DDT dust may be used successfully. The dust may be applied beneath rugs, on floors, and on soil infested with fleas. One-half pound is sufficient to treat 1,000 square feet. If sprayed, one quart of 5 per cent strength will treat 250 square feet applied as a coarse spray.

### *Chiggers*

Fair results were received from dusting areas infested with chiggers with one and 2 per cent DDT. It is, however, doubtful if DDT is as effective as sulfur and other materials in controlling chiggers.

### *Human Lice*

DDT has been used rather extensively for the control of lice on humans, especially among Army and Navy personnel. Remarkable results were received from its uses in combating a typhus epidemic in Italy. Three methods of applying DDT are used to control human lice. They are: (1) powder form, (2) impregnation of garments and (3) liquid preparation. The powder form is applied to the inner surfaces of arm-and-leg sleeves, using about 3 grams per sleeve or the equivalent of approximately 2 ounces per person. While as low as .1 per cent DDT powder is effective in killing lice, 10 per cent is preferred because it has a lasting effect of between 30 and 40 days. It takes longer for the DDT to kill freshly fed lice than those which have been starved. Garments impregnated with emulsions of 1 per cent DDT gave good control of lice after four washings. Fifteen grams, equivalent to 2 per cent of the weight of the garment, gave protection against lice from six to eight weeks and through six to ten washings. Liquid preparations of DDT have been very useful as an auxiliary treatment in the complete delousing process, particularly for the control of head and crab lice. DDT powder used by the soldiers has also been found effective for the treatment of heads of children infested with head lice. Due to the fact that much of the powder falls or is combed from the head the dusting should be repeated within ten days. DDT is not an ovicide, that is, it does not destroy the eggs of lice, therefore, the second dusting provides treatment for the newly hatched lice. The powder may be applied from a can perforated at the top for sifting. For treatment for the body lice the powder should be dusted on the inner surface of clothes, especially to the seams. One to 2 ounces is sufficient for treating one individual. The powder should be well distributed through the hair of the head for treating head lice, and to the hairy areas of the body for the crab lice.

### *Ants*

Ten per cent DDT powder in talc and 5 per cent DDT in kerosene gave fairly good control of most house ants when applied to nests and runways. It is doubtful if DDT is as good as some other insecticides such as poison baits, fumigants, etc., in controlling several species of ants.

*Roaches*

All common house roaches except the German roach can be killed by the use of either 5 per cent DDT spray or 10 per cent DDT powder. Higher concentrations of sprays and dusts have been fairly effective in controlling the German roach. The spray may be applied by an ordinary sprayer or with a paint brush to the infested areas. Dusts should be applied to roach runs and cracks and crevices, and behind objects where the insects commonly hide. It is well to spray underneath tables and other furniture used in kitchens. Some sprays are effective against the eggs when applied directly. It is very difficult to eradicate roaches from homes, eating establishments, etc., because of many chances of reinfestation from outside sources. Some baits impregnated with DDT have proven successful. One to two grams of DDT incorporated in 100 grams of food mixtures gave good results.

*Ticks*

Ten per cent DDT powder and emulsions containing 5 per cent DDT when applied to dogs gave satisfactory control of the brown dog tick, *Rhipicephalus sanguineus*. The action of DDT on ticks are somewhat slow and it is usually necessary to redust dogs at frequent intervals in order to get best results. Engorged ticks are very difficult to kill. The dust or spray may also be used to treat homes, dog kennels, and other places infested with the ticks. An emulsion containing 5 per cent DDT is effective in controlling larvae of the lone star tick, *Amblyomma americanum*. Dust containing 10 per cent DDT has been fairly effective when dusted on lawns and shrubs infested with ticks. The kind and concentration of the diluent used will determine whether or not a spray can be safely used on vegetations or animals.

High concentrations of DDT in solvents have indicated varying degrees of control of the relapsing fever tick, *Ornithodoros turicata*.

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# The Treatment of Poisonous Snake Bites in Texas

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We have in the United States only two classes of poisonous snakes: first, the Crotalidae, or pit-vipers, including the rattlesnakes, the massasauga or pigmy rattlesnakes, the copperhead, and the cottonmouth moccasin; and, second, the harlequin or coral snake and Sonoran coral snake. The pit vipers have stout bodies, thin necks, and flat triangular heads; a blind pit between the nostril and the eye on each side of the head; two long hollow fangs, in white membranous sacs that fold back against the roof of the mouth and which can be elevated at will; vertical elliptical pupils like a cat; single scales on the under surface of the body including the tail. The rattlesnake and the massasauga have in addition rattles at the end of the tail. When first born they have a button and then acquire a rattle every two months during warm weather. The cottonmouth and the copperhead and the coral are poisonous but do not have rattles. The coral snakes can be identified by broad black and broad red bands, divided by narrow yellow bands that completely encircle the body.

There are in Texas five species of rattlesnakes of the Crotalus family; the Western Diamond Rattlesnake, the Banded or Timber Rattlesnake, the Black-tailed Rattlesnake, the Prairie Rattlesnake and the Green Rattlesnake.

The Western Diamond Rattlesnake is the second largest rattlesnake and grows to seven feet in length. It is of a dull yellowish brown with pinkish, light blue, or yellowish-gray diamond bands around it, which identifies this snake. The abdomen is yellowish. It is found in the subarid and desert regions of Texas.

The Banded or Timber Rattlesnake grows to six feet in length, and is yellow to brown, and olive to black, with dark cross bands, edged with a yellow and black tail. It is found in extreme North-Eastern Texas, and sometimes in swampy land.

The Black-tailed Rattlesnake grows to four and a half feet in length, and is of a rich sulphur-yellow, yellowish brown or olive, with a series of brown rhombs down the back. The center rhombs usually have two yellow blotches. The tail of this snake is uniformly black. It is found in West Texas, as far east as Bexar County.

The Prairie Rattlesnake grows to six feet, and is a greenish-yellow or olive, with subquadrate large brown blotches upon the back and with small faint blotches on the sides. The dark band from beneath the center of the eye to the angle of the mouth is the special mark of identification. It is found in Western to Central Texas, in the dry plains region.

The Green Rattlesnake is the smallest, usually, about two feet long. It is an ashy gray of rich dark green, with 19 black bands across the back and a kidney-shaped spot on the base of the skull.

There are two kinds of pigmy rattlesnakes, the Southern Pigmy, which is about 18 inches in length, a dark ashy gray, with large black blotches on the back separated by red scales in the central part of the back; the reddish tail is the special mark of identification. This snake is found along the coastal region of East Texas.

The Edwards Massasauga, of the pigmy rattlesnakes, is about three feet in length, with blotches on the back smaller and more widely separated. Those on the sides are very small. It is found in West Texas.

The moccasins, which belong to the Ankistrodon family, are: 1. The Water Moccasin or cotton-mouthed snake, which averages four feet in length. Its color is a dull olive, chestnut or brownish on the upper surface, paler on the sides, with faint dark vertical bands, which enclose areas of ground color and dark blotches. The head is slightly more than purplish black. The abdomen is yellow, with blackish blotches covering half its area. It is found along the Rio Grande and its tributaries. 2. The Copperhead Snake or Highland Moccasin is about three feet in length. It is of a hazel brown above, with large cross bands of chestnut, and dark chestnut blotches on the sides which resemble an inverted "Y". The abdomen is yellow with 35 to 45 dark blotches. The top of the head is copper colored, with cream colored sides. It is found on high ground, throughout Texas.

The Coral Snake of the Micrurus family, is the only member of this group found in Texas. It attains three feet in length at adult age. The Coral Snake is black from the end of the nose to the back of the eyes, then a band of yellow, followed by a black band, and a narrow yellow band followed by a broad red band. There are from 14 to 19 broad black and broad red bands, separated by narrow yellow bands around the body, and two black and two yellow bands around the tail. All of the colors completely encircle the body, which is the distinctive marking of this snake. It is found in Central and East Texas.

Most of the poisonous snakes belong to the pit-viper family, which includes the rattlesnake proper, pigmy rattlesnake, the copperhead and the moccasin. They are identified by their flat triangular heads, thin necks, stout bodies, short tails with a single row of scales underneath, elliptical pupils like a cat, large fangs that fold back against the roof of the mouth, and a deep pit between the nostril and eye on each side of the head; from which latter characteristic, this class of vipers derives its name. The only other poisonous snake is the coral snake, which, because of its small size, small fangs and mouth that can only be opened to about 30 degrees, renders it dangerous only when it strikes a finger or a toe.

The poison glands of the snake are on each side of the head, below and behind the eyes. They are surrounded with a capsule of fibrous tissue, which is a prolongation of the zygomatic ligament and the fibers from the temporal muscles. The excretory canal, emerging from the gland, goes upward, then forward and downward, to connect with the lumen of the fang. The main pair of fangs are attached to the anterior part of the maxilla and fold back against the roof.

of the mouth. When the snake bites, they are raised by the pterygoid bone and muscle to an angle of 90 per cent.

The venom is a thick, amber colored liquid, neutral or slightly acid, and has a specific gravity of 1.030 to 1.050. It is soluble in a normal salt solution, and generally, in distilled water. When dried, it forms clear yellow crystals, in elongated laminate. It is composed of the following: (1) A powerful fibrin ferment; (2) an antifibrin ferment which attacks the coagulating element of the blood; (3) a proteolytic ferment which dissolves the muscles; (4) cytolysins, which dissolves the red and white blood cells, endothelial and nerve cells; (5) an antibacteriocidal substance of the nature of an anticomplement; (6) neurotoxins, with a special affinity for nerve cells; (7) a neurotoxin with an affinity for the nerve terminals of the muscles, and (8) a substance which reinforces the cardiac tonus and causes the heart to stop in systole, in some cases.

In December, 1920 I took charge of Camp Bullis, Texas, and found that we were having a rattlesnake bite for every thousand soldiers there each year during target season and maneuvers. I had been shipping poisonous snakes and other reptiles to the American Museum of Natural History of New York, the Field Museum of Chicago, the San Diego, New York, and Philadelphia zoos, so it brought me in touch with the leading herpetologists of the country and incidentally with the approved methods of treating snake bites. In the summer of 1925, I was shipping to Dr. R. L. Ditmars, of the New York Zoo, some rare black-tailed rattlesnakes from El Paso, Texas, and I was bitten on my thumb by one of them. I drove to the William Beaumont General Hospital at El Paso an hour later for treatment. I found that they did not know how to treat snake bite and when my pulse stopped the doctors became frightened, but soon started it again with adrenalin, although they were unable to start it with amyl nitrite. We had two cases of rattlesnake bite in San Antonio where the pulse was so weak that it could not be felt for many hours. In one case a soldier's pluse could not be felt for 24 hours and in another case a woman's pulse could not be felt for 19 hours. Both of these cases recovered.

Many suggestions have been made as to how snake bite should be treated, so through Dr. Dudley Jackson and Dr. R. L. Rhea about 400 experiments were carried on with live animals to test the various treatments recommended. The Antivenin Institute of America sent us about two thousand dollars' worth of antivenin to try out. Eventually, the following treatment was adopted. The death rate at the Robert B. Green City and County Hospital, San Antonio, Texas, has been reduced 90 per cent since this method was perfected. We give the first aid directions for the patient, which are used before arrival at the hospital.

1. Tie a tourniquet about two inches above the bite. A rubber band is best, as it can be left on. Otherwise, use a shoestring or handkerchief and loosen it for half a minute every twenty minutes. Do not tie too tightly. We have had a number of cases of amputation as a result of gangrene caused partly by tight tourniquets left on too long.

2. Apply an antiseptic to the bitten part.

3. Keep the patient as quiet as possible.

4. Make a cross-cut incision one-quarter by one-quarter inch over each fang mark and at least one-quarter of an inch deep and quite through the skin and fat. The swelling is so rapid that there is little danger of cutting an important blood vessel.

5. Apply suction to the cross incisions. (The Army Medical Department has issued a large number of excellent snake-bite outfits supplies by Becton Dickinson & Co., Rutherford, N. J.) If a rubber bulb is available, as furnished with the Becton Dickinson and Dudley snake kit, or a breast pump or any rubber bulb found in households, squeeze out the air and apply to the wound, and when it drops off, squeeze out the liquid and apply again. Keep on repeating the application until a physician is reached. The Dudley kit has the large circular metal applicator for flat surfaces and a smaller applicator for use on fingers and toes. When the Dudley kit is not available, squeeze the neck of the rubber bulb and it will form a semicircle and fit part-way around a finger or toe. When a flat surface is treated only the rubber bulb need be squeezed. The mouth may be used in some cases, or a rubber tube or a pipe might be used with cotton in the mouth end to keep the venom from getting in the mouth. However, there is no danger from swallowing rattlesnake venom as it is destroyed by the gastric juice. This I know from personal experience (see *a* at end of this paper).

6. The suction should be continued, and do not be disappointed if you do not get much liquid the first hour, for as the swelling increases you will get more. By loosening the tourniquet now and then you can increase the fluid extracted. Remember three drops of venom will kill, so if you only extract one drop the first hour you may save a victim's life. The banded or timber rattlesnake gives at a bite about 90 mg. of venom or four drops, and the copperhead gives two drops, while the massasauga gives only 6 mg. of venom, which will correspond to about one-fourth of the weight of a drop of copperhead venom (Bul. A.I.A., Vol. II, No. 4, p. 104-108).

7. When the bleeding is excessive, press over cut with finger and when it stops, make a new cut nearby.

8. If you have antivenim serum, which is the serum used for the treatment of the bites of rattlesnakes, massasauga, copperhead, and cottonmouth moccasin, inject it into and around the bite; to get the maximum effect it should be used within one or two hours after the bite. Five syringes of antivenim is the amount recommended by Dr. Dudley Jackson of San Antonio when the patient is bitten through the bare skin, but in some cases less than five syringes of antivenim have saved life. (See *b* at end of this paper.)

9. After using antivenim, do not use mechanical suction for one hour, as you do not wish to withdraw the antivenim.

10. Keep up the mechanical suction for at least 20 minutes an hour for 15 hours or more as the venom may be withdrawn 14 hours after the bite. (See *c* at close of paper.)

The following are the routine directions for the physicians at the

Robert B. Green City and County Hospital at San Antonio, Texas, by which the death rate from the bite of poisonous snakes has been reduced 90 percent. This is the hospital treatment after the first aid has been given.

1. Release tourniquet and apply rubber tourniquet at the upper edge of the swelling, just tight enough to obstruct the lymph channels. A rubber tourniquet tied in that manner may be left on for several hours, but if it gets too tight from swelling, remove it and apply one inch higher.

2. Apply antiseptic dressing to site of bite.

3. Take a specimen of the blood and have it typed and matched, and procure a donor for transfusion is needed.

4. If incisions have only been made over the site of the bite, inject novocaine and encircle the edge of the swelling with cross-cuts one-fourth by one-fourth by one-fourth of an inch deep and about one inch apart. Cut well through the skin and fat into the subcutaneous lymph spaces. A finger or toe would have to have smaller cross cuts closer together.

5. Inject morphine or other effective sedative.

6. The mechanical suction is kept up continuously for one hour and a half in the emergency room, after receiving the patient. As the swelling increases, remove the tourniquet and encircle the limb with cross-cuts one-fourth by one-fourth inch and one inch apart, and apply suction and re-apply the tourniquet an inch higher. One percent saline solution injected in and around the bite dissolves the venom and makes its extraction easier.

7. The compressed air suction machine used in tonsillectomies can be used but it is more painful. The applicators furnished with the Dudley kit should be inserted into the end of the rubber tube.

8. If a blood vessel is cut, plug cross-cut with cotton and make a fresh incision near-by.

9. After suction has been applied for an hour and a half in the emergency room, inject 50 cc. or 5 syringes of antivenim into and around the area of the bite. If the swelling has advanced above the wrist or the calf of the leg, inject 15 cc. of antivenim along its upper margin.

10. Remove the patient to his room and apply hot fomentations of magnesium sulphate or Epsom salts and repeat this every hour Keep the limbs slightly below the level of the body. This, by the way, increases the pain but what is more important it increases the drainage from the cross-cuts. The hot dressing is kept on continuously except when using the mechanical suction.

11. At the end of an hour after injecting antivenim, re-apply suction for twenty minutes and then at intervals of forty minutes for 15 or 20 hours or as long as fluid can be extracted, for the fluid contains venom.

12. Antivenim (Nearctic Crotalidae) or North American Anti-Snake Bite Serum is a purified and concentrated serum globulin obtained from horses which have been highly immunized against the

venoms of North American poisonous serpents of the zoological family Crotalidae.

13. Fatalities from rattlesnake bites in and around San Antonio, Texas usually occur from 24 to 36 hours after the bite, although we have had two cases die within 40 minutes.

## SPECIAL WARNING TO PHYSICIANS

The venom of the rattlesnake, copperhead, or cottonmouth moccasin, is a thick colloidal substance usually slowly absorbed through the lymphatics and grave symptoms may not occur until the swelling reaches the body. As long as the swelling increases continue the active treatment and in no cases stop in less than 15 hours.

When the swelling increases, the blood pressure falls, and the pulse rises rapidly, repeat the antivenim.

Most patients die from under-treatment and none from over-treatment. When in doubt, increase your treatment. The cases at the Robert B. Green Hospital are discharged in one-sixth the usual time at the Station Hospital at Fort Sam Houston, Texas, where the patients receive about one-sixth the amount of active treatment.

Gas bacilli (B. welchii) have been found in the mouths, or the venom, of 100 per cent of the Texas diamond-back rattlesnake, examined by Dr. Dudley Jackson in San Antonio and frequently in the victims' bites. Upon the least suspicion of such an infection, deep drains are called for. Withdrawal of the serum removes the culture medium of gas bacilli and decreases the danger of this complication. The combined prophylactic injection against tetanus and gas bacilli should be given.

If the patient shows signs of shock, give transfusion of about 500 cc. of blood; 500 cc. of an isotonic or .9 per cent saline solution or 500 cc. of a 5 to 10 per cent glucose solution. When the blood pressure drops to 84/70, 500 cc. of a 5 to 10 per cent glucose solution has raised the blood pressure to 110/80, when given intravenously. However, it was necessary to repeat the dose every four hours for some time. (See my report in the Military Surgeon for July, 1931 on the treatment of shock in rattlesnake bites.)

When the red blood count drops to one-half the normal, blood transfusion is indicated. (See Dr. Dana Atchley's report to the *Journal of the American Medical Association,* August 9, 1930, where he reports giving 700 cc. by proctoclysis and intravenously within 16 hours in severe case of rattlesnake bite.)

Preparations for transfusion should always be made in advance, even in apparently mild cases, as such patients often suddenly collapse and it becomes urgent. I have known two fatal cases resulting from neglect to have a donor ready.

It is important to type and match the blood immediately on arrival, as the hematoxic action of the venom may render it difficult later. In that case, it would be advisable to use the universal donor, type 4.

When the veins have collapsed, as occurs in small children, inject the blood into the buttocks or into the peritoneal cavity and do not waste time trying to find a vein.

Wash out the lower intestines with high colonic irrigation of magnesium sulphate every four hours and also give Epsom salts by the mouth, as the venom is excreted through the intestinal mucoso, and in that way it may be washed out of the system.

Repeat the dose of antivenim if more neurotic symptoms occur.

Rattlesnake venom is about 75 per cent hemotoxic and 25 per cent neurotoxic. The hemotoxic action is best treated by mechanical suction, and the neurotoxic by antivenim. The latter can be aided by the removal of the highly toxic fluid due to the action of the venom on the tissues by using mechanical suction.

No cases of rattlesnake bite are adequately treated until they are surgically treated, and all physicians should be prepared to save human lives by applying the above method of treating the bites of pit vipers, the rattlesnakes, copperheads, and cottonmouth moccasins.

The author wishes to acknowledge his indebtedness to the following who made this paper possible: Dr. Dudley Jackson, San Antonio; Dr. R. L. Rhea, veterinarian, San Antonio; Major W. C. Cox, M.C., U. S. Army; Major R. E. Scott, M.C., U. S. Army.

(a) I was collecting venom at Floresville, Texas, for the Antivenim Institute. One Sunday I went down to extract the venom from 210 live rattlesnakes. Major Scott, my usual assistant, was not with me, and the owner said he had a rush order to ship the snakes within three hours, so I must be through within that time, if I wished to start the job. It was extremely hot, over 110 degrees F. in the tin shed. It was so hot that the venom was drying in about ten minutes in the Petrie dish into which I milked the snakes, so I had to pipette it from the dish, put it in a test tube and plug it with cotton every few minutes. I lost so much time pipetting the venom that I tried to work faster and succeeded in milking ten between pipetting. I then milked 15 snakes very rapidly and when I tried to pipette the venom the tip of my pipette was stopped by the coagulated venom. I gave a strong pull. The cotton at the mouth-end of the pipette slipped into my mouth and tickled my throat. There was a nasty taste in my mouth, the Petrie dish was empty and 3.3 grams of venom were wasted. I had to work harder then, but succeeded in extracting the venom from 210 snakes within three hours.

(b) In the following case the patient recovered after the use of two syringes of antivenim. About 1:00 A.M., May 30, 1929, Mrs. L. H. was sleeping on a pallet on a screened porch with her husband and nine months old baby boy between them. She awoke with a sharp pain in the center of her forehead and thought she had been stung by a scorpion or other poisonous insect, as she heard no sound. She went to the kitchen to put some cold water on the bite, but the pain drove her frantic, so she got some matches and woke her husband and told him to look for what stung her, for it might bite the baby. Her husband reached across the baby to light the match on the floor and as it flamed up he saw a rattlesnake under his arm and near his little son's head. He dropped the match and screamed for something to kill the snake with. A lantern was brought and a hammer was given him, and he struck at the snake as it was escaping through a hole in the floor. Dr. W. H. Smith of Hondo, 14 miles away, was telephoned to and arrived within an hour. By that time, Mrs. H.'s head was so swollen that her features were obliterated. She vomited blood and blood was excreted from her bladder and bowels. She was given a syringe of antivenim and removed to Dr. Smith's hospital where she was given another dose of antivenim. She was discharged within three days, made a rapid recovery, and had no ill effects.

(c) For example, we had an old negro bitten by a rattlesnake, 14 hours before, and we tried to find how long the venom remained in the system. The bloody venomized serum, extracted by mechanical suction, was saved and injected into an animal that had the same resistance as a person of the patient's weight. The animal became seriously ill and close to death, from which we were satisfied that if the venom had been left in this old negro he would have died.

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## Texas Resources and Industrial Expansion

VICTOR H. SCHOFFELMAYER
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We are assembled here in the nation's greatest raw materials state—a state which not only leads America in agricultural production, but one which is a veritable storehouse of basic minerals and metals needed by a steadily expanding industry.

We are in the Postwar Era, but because we were caught largely unprepared for the quick surrender of Japan, we have not made the progress in reconversion which had been anticipated. It is needless, however, to say that as a nation we will get our postwar stride just as soon as the present misunderstandings between industry and labor are ironed out.

In the great industrial peacetime development upon which America will enter, Texas is destined to play a major role, just as the state made its notable contributions to the development of war industries which brought final victory.

For 100 years Texas has largely contented itself with an agricultural and livestock economy. Our ranchmen built up vast herds of beef cattle to consume the wild grasses of our prairies and plains. These plains and prairies later were plowed up by farmers who brought with them the inherited agriculture of the East and South, and cotton became the leading crop.

Cotton, and a too limited crop variety—corn, wheat, oats, roughage—failed to bring wealth to our producers on the land. A short-sighted cotton policy, abetted by our money-lending system, has resulted in depletion of our best soil and in the ruination of tens of thousands of our farm people whose land no longer will provide the financial returns essential to a decent standard of living.

Under that system Texas agriculture sank into a state of farm tenancy and quasi-poverty, which in turn brought federal restriction of both acreage and crops. Whether this attempt at solving economic evils with political controls was a success I leave to be answered by others.

With the war came a demand for all-out production of food and feed. Cotton failed to play an important role in this conflict such as it played in World War I. Cotton acreage in Texas has fallen in the last fifteen years from about 18,000,000 acres a year to 7,000,000 acres this season.

It is not necessary to emphasize that Texas cotton has been tobogganing downhill to what appears to be virtual obliteration of this state as America's No. 1 cotton producer. It may well happen that another state, such as Mississippi, might soon outproduce Texas in the coming years unless drastic measures are taken to restore Texas' leadership.

But one wonders whether the basic changes which are reshaping our whole world economy are not also at work in our own state and the Southwestern Region and will continue to bring about profound readjustments to events taking place elsewhere.

It is not impossible that America's cotton supremacy, enjoyed for sixty years or longer, will pass to India, Brazil or Russia.

I see great changes ahead for Texas cotton. That portion of the crop which will still be grown in our region, is likely to have the benefit of science and invention in the form of labor-saving machines which will make cotton a completely mechanized crop from planting to harvesting.

When that comes cotton will have a new day because with mechanization of our vast West Texas Plains it is possible to produce cotton at a cost of around 5c a pound, which would make it a basic raw material not only for the textile industry, but also for all industries dependent upon cellulose.

Cotton linters are industry's finest alpha cellulose. It is now possible, however, to cut up lint cotton into linters at low cost and convert them into easily chemicalized raw material which in turn will convert it into rayon and other synthetic fiber material. There is a new field for low-cost cotton in which Texas may play a big role.

But let us look at the new horizons in Texas industry, those which came about during the recent war.

That brings me to a consideration of the new era of development which lies ahead of Texas.

During the recent world war the state of Texas surpassed all expectations as a producer and processor of many raw materials which were essential to winning the war.

We need only compare the state's output of manufactured goods, which in 1939 were valued at $1,500,000,000, with last year's estimated $4,500,000,000, largely war contracts.

Government and private investment in manufacturing plants during the 1939-44 period is in the neighborhood of two billion dollars. We have, therefore, a huge potential plant to be kept in operation during the postwar era. Many of these plants, however, will not be needed in a peacetime economy. Many, such as some of our largest airplane factories and shipyards and munitions plants, are now being junked.

There will remain, however, a nucleus upon which Texas may build a new industrial future. Some of these large plants will be converted to the manufacture of quick-freezing units, air-conditioning sets, small motors, trucks, automobiles, electrical equipment and hundreds of gadgets made from Texas magnesium, Texas-smelted aluminum, laminated wood, glass sand and clays, Texas synthetic rubber and chemicals.

The great chemical industries along our Gulf Coast are not likely to fold up, however. They have earned an important place in our modern American industrial program. They will be needed to produce regionally the plastics, chemical salts, textile fibers, oils, motor fuels, high octane gasoline, styrene, butane, butadiene and other ingredients of synthetic rubber, the source of our automobile tires and the source of thousands of articles to be made of synthetic rubber and near rubbers made from combinations of plastic materials now only hinted at.

In the Corpus Christi area are such plants as Southern Alkali Corporation producing needed soda ash from salt and brine, and oyster shell in place of limestone. At Bishop, not far from Corpus Christi, is the large new Celanese Corporation of America plant making acetic acid, acetic anhydrite, acetone and methanol as well as formaldehyde. When in New York not long ago I asked the company heads about this plant and was informed that this company no longer is content to produce merely textile fibers. It has gone chemical and will produce chemical basic materials as are now produced by the largest chemical firms of the nation.

Dow Chemical Company's huge plants at Freeport and Velasco on our Gulf Coast represent an estimated investment of $150,000,000 and will continue to produce magnesium and bromine from sea water and caustic soda and chlorine. Such gases as ethylene, propylene glycol and atmospheric ammonia are other chemicals to serve the needs of new Texas and Southwestern industries making plastics of many kinds, some of which are revolutionizing the nation's manufacturing processes.

To other areas of the Texas Gulf Coast have come such giant industries as Monsanto Chemical Company, Du Pont de Nemours & Company to Orange where a large chemical plant is to be set up to make Nylon salts and a smaller agricultural chemical plant at Houston.

Near Austin International Minerals and Chemical Corporation during the war operated a huge magnesium plant using Texas dolomite from the Edwards Plateau. Among other great chemical industries looking to Texas or established in this state is American Cyanamid.

But probably the greatest single chemical development which has caught the public imagination is the construction and operation during the war of an integrated series of hydrocarbon refining plants engaged in the production of 41 per cent of America's synthetic rubber from the butadiene and styrene of our Gulf Coast refineries. These vast plants in the Beaumont-Port Arthur, Houston-Baytown areas, built by Defense Corporation and operated by the big rubber companies of Akron, are monuments to chemical progress which sets a milestone along the road of scientific advancement.

What the future of these plants may be, if our national policies again should encourage the uninterrupted import of natural rubber from Malaysia is any one's guess. Synthetic rubber, though, it seems, has already won an important place in the national economy. It is not real rubber, and for that very reason it is likely to hold its place for a thousand new uses for which it is better than natural rubber, especially such uses as bring it into contact with gasoline or oils.

Scientists with whom I have had the privilege of talking have stated that synthetic rubber and natural rubber both will have their continuing place in the American and world industrial economy because each is entirely different from the other. Each is best for a certain use. It is quite likely that there will be an important place for both in our postwar era.

We have dealt up till now largely with the wartime industrial development. We will now discuss the peacetime economy, which will call for many products which need not be based upon these new chemicals.

The western world's traditional industrial economy for 175 years has been based upon the trinity of iron, coal and limestone, as we all know. This trinity, however, may be challenged shortly by one based upon such an extensive raw material as Cellulose, Petroleum and Natural Gas and Ethyl Alcohol. These new raw materials of industry can be grown year in and out—they will not become exhausted as will iron, coal and other minerals and metals. They are the product of sunshine, air and water. They will be produced as long as man cares for his land and the sun shines and the rain falls.

We must remember that Texas, after all, is America's greatest agricultural state. It can produce its 6,000,000 bales of cotton, even though this season we are raising only 2,000,000, the smallest crop in 50 years. It can grow 100,000,000 bushels of grain sorghums which could become the basis for the production of several lines of plastics which are likely to forge ahead of other plastics, either as textile fibers replacing cotton, silk, wool and linen, or as plastics to be extruded or form-shaped, rolled or made into tubes, sheets or cubes for later conversion into consumer articles.

Let us not forget that cellulose and lignin constitute the bulk of a tree, or of a cotton plant, corn stalk or most any plant. These plants grow from year to year. Unlike the established raw materials of the Machine Age—iron, steel, coal, copper, aluminum, nickel, manganese and others—which are being steadily depleted, these organic raw materials reproduce themselves each year through the energy of the sun and the influence of the rain and the carbon dioxide of the air. They will be here long after the inorganic raw materials have disappeared or have become prohibitive for many uses to which we have become accustomed.

Petroleum and natural gas, too, and many other so-called inorganics, will disappear just as they have vanished from many an area of West Texas and other areas, leaving ghost towns and a blasted countryside behind them.

The newer application of chemistry and physics to the organic raw materials of farm, forest and ranch, changes surplus corn cobs into furfural, sugar cane bagasses into cellulose plastics, wheat straw into wallboard and packaging material, sawdust and other wastes of our lumber mills into sugar, alcohol, stock-feed yeast, charcoal and into motor gas, through distilling the wood in a retort, as was done in Germany, Sweden and Brazil on a big scale all during the war.

We must begin to think in terms of ever renewable raw materials —organic materials which can be synthesized into substitutes for iron, steel, copper, clay, stone, glass and other traditional raw materials.

We will continue to use the long established materials for many years, but many of these are disappearing. We might have to import them. That alone will give great impetus to a new economy in which new crops are grown over most of this country and state, and over a large portion of the world.

Among these ever renewable materials none is of greater importance than our forests—the tree and the wood, which we are just beginning to understand chemically.

The Germans almost won the war with the aid of alcohol produced from their own forests and those which they took over in conquered lands. The German chemists call wood a universal raw material—Universal Rohstoff. They see in it more chemicals than in coal and they built an entirely new industrial economy upon wood, largely through use of sugar, ethyl alcohol, acetic acid, acetone, furfural, oxalic acid, wood gas, and by-product yeast captured from the air and built up from the distillation products of wood. All these chemicals come from the cellulose contained in every tree, in fact in every plant. But there also is lignin in wood, a material about which we know very little. It is believed by some chemists that lignin some day will pay the entire cost of wood distillation and thus make alcohol from wood practically free. You can see that great things seem to lie ahead of a wood-use economy. Texas had better get in on the ground floor of these important researches, since we have some 13,000,000 acres of forest lands in East Texas which could become a center of great new chemical and other processing industries when we learn how to use wood in a modern way.

I will give you some figures—from one ton of sawdust or other wood wastes at our sawmills we can obtain 1,100 pounds of sugar, just as good as any on your table tonight. In addition to that sugar the chemist obtains from the same ton of sawdust about 650 pounds of lignin.

If, however, he wishes, the chemist can convert that 1,100 pounds of wood sugar into 60 gallons of ethyl alcohol, the same as the alcohol obtained from wheat or corn or any other grain, or he can obtain instead of alcohol 500 pounds of high protein livestock feed yeast, superior to cottonseed meal and still have the lignin left.

If the waste woods were converted into motor fuel in the form of wood gas 16 pounds of wood would be found to equal one gallon of gasoline.

Texas is America's leading petroleum and natural gas state, so we may not need to make gas from wood very soon, but other states and countries may have to do so.

Wood, one of our oldest raw materials, is now benefiting from scientific research to such an extent that a new series of industries are being set up on its use which consist of wood laminates, wood and metal laminates, in which the metal strips can not be again separated from the plywood, or wood can be hardened chemically to become an almost new material which does not absorb water, or it can be softened to permit being twisted into any shape wanted and then again hardened to retain that shape. Wood, after 4,000 years of misuse and abuse, has been rediscovered by our chemists and physicists and no one can see its future possibilities in entirety. Texas needs to be aroused to the possibilities of this great resource so that adequate industrial uses can be made of it right here at home.

But what I have said about our trees—pine trees and hardwoods —can be applied to such rapid-growing crops as Bamboo, which we can grow in East Texas, or to many other plants which need not be named.

Our agricultural economy will undergo still further changes. We should raise a large part of our own vegetable oils, instead of importing them. We import annually about 1,500,000,000 pounds of vegetable oils from the South Seas and Asia all of which we could grow at home and thus set up new industries and afford employment which is needed in Texas and the South.

The principal imports are listed below:

5,500,000 tons of Sugar from Hawaii, Cuba and the Philippines;
5,000,000 tons Wood Pulp and Paper;
1,500,000 tons of Vegetable Oils (linseed, tung, soybeans, castor beans, sunflowers, perilla, et cetera);
700,000 tons Natural Rubber from Malaysia;
500,000 tons Wool from Australia, New Zealand and Africa;

500,000 tons of Vegetable Gums, Waxes, Resins, Aromatics and Essences, Drugs, Flavors, Spices and Insecticides;
450,000 tons of Coarse Fibers such as jute, Manila hemp;
300,000 tons of Root Starches and Tapioca.
Other thousands of tons of dyestuffs, tannic acid and tanning barks, human hair, kapok, and other fluffy fibers, ebony, mahogany, balsa and other woods.

Then there is the overlooked field of aromatics and essences, of drug crops and flavoring materials, practically all of which have been imported in the past. Texas farmers can raise many of these.

Also, the food production program can be expanded through efficient use of quick-freezing and dehydration. These two really complement each other and should be allied. The wastes of quick-freezing such crops as spinach or cauliflower or broccoli are enormous. The wastes can be processed into high protein stock feed and such industries are now beginning to be established in our Rio Grande Valley and elsewhere. These are new opportunities of great importance in our postwar era.

Science and research point the way to our industrialists and farmers. Without the aid of science and research there can be no real progress either on the industrial or agricultural front. They, too, must supplement each other and bring about new thinking and new achievement which will be reflected in new stability and new prosperity for our great state in the years to come.

# SECTION I. PHYSICAL SCIENCES

## PAPERS

### Research and Training for Defense

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The slogans introduced during any war—"To save the world for Democracy", "The war to end all wars"—have their wartime function of improving morale both on the home front and within the armed services. They have the unfortunate function, also, of building false hopes in the minds of any peace loving people who are most anxious to believe that some utopian means will be found to prevent future wars. We as a national community—more so as a world community, perhaps—do not yet know enough concerning relations between individuals, communities, and nations to justify much optimism for perpetual peace. Until the social scientists, diplomats, and politicians have progressed much further in their understanding of the fundamental relations between communities of human beings, it is essential that we maintain a state of preparedness sufficient to defend ourselves from any aggressors at any time.

With the advent of undeclared war, atomic bombs, guided missiles—not to overlook long-range, high-speed bombers—an aggressor has such marked advantage over an unsuspecting nation such as the United States that one might be inclined to despair of a solution if it were not for our large geographical distribution and the possibility of large numbers of our citizens becoming properly alarmed over our national security.

A naval officer who has the responsibility of formulating the research policies of one of the Bureaus recently wrote, "Looking back at the war just completed there were many indications which pointed to the beginning of the war, but the United States has been notoriously slow in recognizing the symptoms of war and has twice been saved from complete catastrophe by the assistance of our allies. . . . The next nation which attacks the United States will have studied carefully the results of a hard, aggressive, determined attack, and it is most probable that if a nation ever decided to attack the United States, it will attack secretly, quickly and, they will hope, with decisive results."

He then points out that "it has been said that this war has been a physicists' war. The physicists have done noble work and without that work the final culmination would have been delayed and would have been at a greater cost. However, the Japanese were stopped and turned back with weapons developed before the war by the armed services." It is well known that during World War II, even with the entire country mobilized, in no major new developments was it possible to do the research, engineering, and production in significant quantities in less than eighteen months.

Furthermore, since there has been very little basic research done since 1940, it is imperative that increased opportunities be made available for the increase in basic knowledge in the United States.

It seems logical, therefore, that the congress, the armed services, and a large number of scientists are so concerned with our future that several alternative avenues of participation are being opened to the colleges and universities.

At this time there would appear to be three possible major sources of government funds to support research: first, by direct subsidy for fundamental research; second, by contract with one of the armed services for basic research; and third, by contract with one of the armed services for the purpose of producing a new weapon or military device.

Dr. Bush in his report, "Science the Endless Frontier" has proposed a plan very broad in scope. If the Magnuson Bill, which supports the Bush plan, is passed, the colleges and universities will have available a source of money for research which is, for the most part, unrestricted—to mention only one of its provisions. It seems most likely that either this or one of the similar bills now before the congress will be passed at an early date.

Quoting again from the letter previously mentioned, "Since the Navy does require the active assistance of the universities, and since the United States does require an increase in the basic knowledge of its research personnel, the Navy is now formulating policies in order to provide all the requirements laid down by the universities. The Navy's policy will be determined after the problems of the many universities have been studied in order to determine the desires and the capacity of each university, and after some idea of the funds available for this purpose becomes known." The Office of Research and Invention is now negotiating with selected universities for contracts to carry on research in broad fields of interest to the Navy. While I have no such quotation from a responsible Army source, I am certain that their thinking is very similar to that of the Navy.

The nature of the third source of funds is such that they are usually classified but it can be said that several such possibilities do exist now for those institutions which have personnel and facilities especially adaptable to given problems. It is expected that more opportunities of this type will become in the relatively near future.

Assuming that it has been shown that there is urgent need for increased effort in scientific research for defense and that means will be made available for financing it, the next question is, "What is the proper function of a college or university in such a program?"

If prewar concepts are still completely valid, one might reasonably argue that the only function of a university in this research program would be fundamental and basic research of an unclassified nature. Fortunately, a large percentage of the competent scientists of this nation is associated with the universities. It is impractical, therefore, to neglect this potential source of competent scientific brain power. It has been estimated that approximately five-percent of all our scientific effort should be directed toward military matters. Since the government laboratories, including those of the services, are concerned primarily with specific improvements to existing weapons and devices and the industrial groups are interested most in engineering for production, the universities and research foundations must carry a large part of the research load. It is only natural that many competent members of university faculties are interested in applied research and just as natural that the armed services should expect to use the talents of these scientists as well as those interested only in fundamental research. Furthermore, many universities have long ago recognized their responsibility in helping to train officers for the armed services. Equal—if not greater—responsibility now rests upon the universities to see that the United States maintains its just military position through fundamental and applied research.

It is equally important that increased emphasis be placed on training scientists if such a program is to be successful. No fundamental changes in university policies need be considered here, however, for broad fundamental training has been proven to be satisfactory. It is evident that funds for scholarships and fellowships, to be ministered by each university on a very broad basis, including basic research, and for professional leadership will be made available by the armed services and the congress.

## The Influence of the Calcium Content of the Soil on the Calcium Content of Trees

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(Work done under Dr. J. C. Godbey)

The object of the investigation was to attempt to determine whether or not the calcium content of soil affects the calcium content of a given plant in it, and if so, the relationship between their contents.

Some work has been done previously on this problem before. It was concluded that there seems to be a discrepancy in the idea that the calcium content of a plant is directly proportional to the calcium content of the soil in which it grows.

In order to carry out the investigation it was decided to run a series of analyses of the calcium in a given selected plant in the major types of soils and of the corresponding soils that it is in.

The plant to be used was selected after the following considerations:

1. A plant that is indigenous in the major types of soils.

2. A plant from which uniform samples could be taken. After this consideration, it was decided to use a tree. It was decided to take the sample out of the trunk a certain height above the ground and at a certain diameter.

3. A plant that fruits a small amount. This consideration was necessary since a plant that is fruiting causes its composition to vary quantitatively, and since the quantitative content of the con-

stituents of the soil it is in causes the maturity of the plant to vary with respect to age.

4. A plant that is a surface-feeder. The reason for this selection was that a soil sample in which the plant is growing can be taken more uniformly if the soil sample is from a thin layer.

The Celtis occidentalis, which also is known by the name of hackberry, sugar-berry, beaver-wood, and nettle-tree, was selected. The samples were taken out of the trunks. A portion of the entire trunk was sawed out in each case.

The soil that the trees were in was sampled to a depth of two feet because practically all of the roots of the Celtis occidentalis are found between the surface and this depth. The soil sample was taken by means of a soil auger.

The plant samples were prepared for analyses as follows:

1. Part of the portion of the trunk was converted into sawdust by sawing off thin circular slices.
2. The sawdust was mixed.
3. The sawdust was dried at 110 degrees for four hours.
4. About one gram of the dried sawdust was taken and weighed.
5. The weighed sample was incinerated at dull red heat for ½ hour. The reason for this was to remove organic matter.
6. The ash was weighed. The samples thus prepared were analyzed according to the method in the third edition of *Quantitative Chemical Analysis* by George McPhail Smith on page 130; this method was modified in the following way. In the separation of calcium from magnesium by means of ammonium oxalate, instead of precipitating the calcium from an acid solution, it was precipitated in an alkaline solution.

The soil samples were prepared for analyses as follows:

1. The sample was mixed. This was done to be sure that the part of the sample taken for analysis would be representative since there is the possibility that the quantitative composition of the soil varies with depth.
2. The sample was blasted with the heat of a Bunsen burner for ½ hour to drive off moisture.
3. The sample was finely ground.
4. Part of the sample was dried at 110 degrees for one hour.
5. About ½ gram of the part of the sample last mentioned was weighed.

The samples thus prepared were analyzed by the same method used on the plants.

Now if the calcium content of the plant showed certain variations, it could be concluded whether or not the calcium content of the soil affects the calcium content of a given plant in it. If the calcium content of the plant showed no variation, there would remain the possibility that certain plants are not affected by the calcium content of the soil they are in while others are.

In these analyses, calcium of refractory nature was not determined because it was assumed that calcium occurring as such compounds is practically not available to plants.

In drawing the following conclusions, it was assumed that the possible errors from different stages of maturity, different ages and variation in the variety of the plants that were sampled plus the error in assuming the proportionality below is small compared to the difference between any two given results in the data. It is also assumed that the calcium in the soil except that in refractory compounds which is available to the plant is proportional to the total amount of calcium in the soil excepting that in refractory compounds. Following are the conclusions:

1. There is variation in the calcium content of the given plant when in the different types of soils.

2. The calcium content of the soil does not seem to control that of the given plant in it.

This is evidenced when the following is done: If the results obtained for the percentage of calcium in the plant in the different types of soil be arranged in the ascending order, the corresponding results obtained for the percentage of calcium in the type of soil that the plant is in will be in the descending order. There is one irregularity.

3. When the percentages of the calcium in the plant in the different types of soil are arranged in the ascending order, the corresponding percentages of ash seem to also ascend. There is one irregularity.

4. The ratio of any difference between the percentages of the calcium in the plant to any difference in the corresponding percentages of the calcium in the soil seems to be a constant.

There is an irregularity here in addition to the one in conclusion 2. This constant seems to be .0145.

5. The calcium content of the given plant seems to be inversely proportional to the calcium content of the soil it is in.

6. The calcium content of the given plant can be calculated from the calcium content of the soil it is in by the following equation.

$$p = s - (s - 1.31)\ 1.0145$$

where p is the percentage of the calcium in the plant and s is the percentage of the calcium in the soil.

In order to clear up why the calcium content of a plant seems to decrease with the increase of the calcium content of the soil it is in, this problem needs to be investigated in a way that will introduce simplicity and more precision. Chemical gardening, i. e., growing plants in nutrient solutions, may be the solution.

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# Photogrammetry and Map Compilation

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The purpose of this paper is, (1) to present a brief review of some basic principles of map compilation, (2) to present some basic principles of photogrammetry, and (3) to show the function of photogrammetry in map compilation.

The mapping profession has met, in a large part, the emergency demands for maps. This demand has been immense and exacting. Photography and photogrammetry contributed a very large part towards the provision of adequate wartime maps, and will continue to make large contributions to the field of map compilation.

A map is a representation to scale of the earth's surface or a part of the earth's surface on a plane map sheet. The surface of the earth cannot be represented on a plane without distortion of some parts. The location of a point on the earth's surface is described by giving the latitude and the longitude of the point.

The map compiler must first of all decide the position of latitude-longitude lines on the map sheet. The relative position of these lines on the map sheet provides certain desired characteristics for the map. The development of this latitude-longitude grid on the plane map sheet is known as map projection. The standard Mercator projection is a projection that maintains correct angles between lines emanating from a point. Small areas are shown with correct shape. The scale varies with change in position in a north-south direction. Areas near the poles are shown to a much larger scale than areas near the equator. One square inch on the projection at the equator represents an area on the earth's surface approximately thirty-six times the area represented by one square inch on the projection at latitude of eighty degrees. The mapping of small areas on a similar projection will introduce similar but smaller differences in scale ratios. There are many types of map projections, each type designed to meet specific requirements of map users. The projection to give the map the desired characteristics is selected and the latitude-longitude grid is placed on the map sheet according to this scheme.

In all measuring a succession of measurements accumulates the systematic errors of the measuring device, plus or minus the accidental errors of the measuring operation. The total error will probably increase with the total distance measured. The more precise measurements, as a general rule, require more precautions and more expensive instruments and tend to cost more than less precise measurements. For these reasons the most efficient mapping practice requires that the longer distances be measured by the method that will yield the required precision at the lowest cost, and that intermediate points be determined by a method of lower precision and less cost. Detail is then added by a method of least precision and least cost. The more precise positions control the less precise and are called control stations.

For map compilation the control stations must be selected and located on the ground. For maps of large areas the primary control stations are usually located by geodetic control surveys in which latitudes and longitudes are determined by basic astronomic observations and high order triangulation. The secondary control stations are located by less precise triangulation and by traverse.

For maps on which elevations are shown vertical control must be provided. The vertical control is usually obtained by spirit leveling, or for less precise maps by a combination of spirit and barometric leveling.

The control stations are plotted on the map sheet with the previously plotted latitude-longitude grid. The determination of position for the first and second order accuracy control stations has been and is likely to continue for some time to be the province of the ground survey. The position of control points for third and fourth order accuracy control stations may be determined by photogrammetric measurements from the second order control stations.

The completion of the map compilation by adding the detail, before the advent of aerial photography, was accomplished by means of the plane table. In using the plane table, the map was compiled in the field with the ground surface before it as a model. The surveyor would measure as many distances, and would plot directions from control stations to as many detail points, as needed for the purposes of the map. The viewing of objects from the sides and plotting the object as if viewed from above made it necessary to occupy a large number of stations with the plane table, and thus greatly increasing the cost of maps when accurately plotted detail was necessary.

The development of aircraft, photography, and photogrammetry during and since the first World War, caused a gradual replacement of the plane table by aerial photogrammetric methods. The plane table is now used only for contouring on surfaces of low relief, for maps of large scale, and for maps of small areas when suitable photographs of the area have not been made.

An air photograph is a practically complete record of directions from a station to objects appearing on the photograph. The accuracy with which directions are recorded on the photograph is determined by such things as lens distortions, properties of photographic emulsions, and distortions of the sensitized material. In general, we may expect errors in photographically recorded directions of several seconds when all precautions are observed and the best equipment used. Errors of several minutes may be expected when observing ordinary precautions and using ordinary paper prints. An angle of one minute at a distance from the vertex of six inches has an arc of about two thousandths of an inch, a distance barely visible to the eye. The modern transit theodolite will measure an angle with an error of less than a second. It is apparent from these relative accuracies that the modern photograph cannot be used for surveys of geodetic precision, but are suited only to surveys of third or fourth order accuracy and especially to graphic mapping. The completeness of directions recorded on the aerial photograph gives it the advantages of speed, economy and freedom from blunders not found in other methods of mapping. The only detail not available is that covered by other objects and by shadows, and detail that cannot be shown due to the resolving power of the lens-film combination.

A map is sometimes plotted as a top view for an orthographic projection of a portion of the earth's surface. This gives a representation of the earth's surface to a uniform scale if the surface mapped is a horizontal plane. In the aerial camera the photographic film is placed perpendicular to the camera axis. The photographer attempts to keep the camera axis vertical. Obviously the photograph of a horizontal ground surface made with the camera axis in a true vertical is a true representation of the surface to a uniform scale. This photograph is our perfect representation of ground objects to a uniform scale.

There are four inherent characteristics of aerial photography that produces a photograph that is not a perfect map in the sense that a map is a representation to uniform scale of a portion of the earth's surface. These characteristics are (1) the physical fact that the earth's surface is spherical, rather than plane, and therefore cannot be represented on a plane surface without distortion, (2) distortions due to the imperfections of the optical and photographic materials, (3) displacement of image due to the relief of the ground, and (4) displacement of image due to the camera axis not being a true vertical line.

The existence of these four characteristics produces most of the difficulties encountered in map compilation. The displacement due to relief is the key to the representation of the ground relief, which is so desirable on many maps.

The map compiler provides for the desired distortion of the spherical surface by plotting the control stations using the projection method that gives the desired characteristics to the map.

The distortions due to imperfections in camera and in photographic material are kept a minimum by using material and workmanship of the highest possible precision. Aerial cameras are tested and calibrated by the U. S. Bureau of Standards and corresponding precautions are taken in the field to reduce errors to a minimum.

An aerial photograph, with the axis of the camera vertical, will have distorted images of objects with relief. The image of a vertical flag pole, if at the principal point of a true vertical photograph, is a dot. The image of a similar flag pole, if near the edge of the photograph, is a straight mark radial towards the principal point of the photograph. Thus the image of a straight road, at right angles to a radial line and passing over a hill, would be a curve. The position on the true vertical photograph of the image of any ground point with relief is displaced radially either towards or away from the principal point. The displacement is with respect to the assumed image of a point in the datum plane at an equal distance from the principal point. Therefore, the angle on the true vertical photograph between lines connecting the image point with the principal point are exactly the same size as the horizontal angle between lines connecting the ground points with the ground principal point. A true vertical photograph, without camera or photographic material distortions, is a correct record of the directions of all ground points from the ground point represented by the image appearing at the principal point of the photograph.

The radial plot method of locating map points is based on the above principle of relief displacements. Also the measurement of the ground relief is necessarily based on relief displacement. To compile a map from aerial photographs it is necessary that overlapping photographs be made of the area. The necessary overlap in the direction of flight is about sixty per cent, thus insuring that each point will appear in at least three photographs of the flight strip. The overlap in a direction at right angles to the flight line, or between flight strips, is about twenty percent. This overlap provides for proper ties between flight strips.

Each photograph of the flight strip is processed for the radial plot. The principal point and the images of the principal points of the two adjacent photographs, known as the conjugate principal points, are determined and marked. Pass points, near the lateral margins of the photograph and nearly opposite the principal point, are selected and marked. The four images on the photograph of the pass points on the two adjacent photographs of the flight strip are found and marked. Thus on each photograph nine points are marked; a principal point, two conjugate principal points, and three pass points near each of the two lateral margins. The line joining the principal point with the conjugate principal point is the intersection of the vertical plane containing the line of flight and the ground surface.

A template is made for each photograph by placing over the photograph a sheet of celluloid acetate and drawing thereon very fine lines from the principal point to each of the other eight marked points.

To compile the map, to an established scale, requires ground measurements between two control points appearing as images in the overlap area of the first two photographs. Additional control points are necessary along the flight strip to maintain the accuracy of the map. The images of the control points are marked and lines are drawn from the principal point to each of the control point images. All the control points are plotted on the map sheet to the established scale.

The first template is fastened down to a plane board. The second template is placed over the first with the radials from principal point to conjugate principal point in coincidence. The second photograph is slid along this line until the intersection of radials determining the control points are at exactly the correct distance apart for the established scale. Intersecting radials then give the correct position for points opposite the center and near the lateral margins of the second photograph.

The third template is placed over the second with the radials from principal point to conjugate principal point in coincidence. The third photograph is slid along this line until the radials pass through corresponding points already located near the margin of the second photograph. Intersecting radials then give the correct position for the pass points opposite the center and near the lateral margins of the third photograph.

The procedure is extended to include all the photographs of the flight strip. The adjacent flight strips are placed in the same manner using points in the strip overlap area of the preceding strip as control points. The assembly of templates is placed over the plotted control points so as to get coincidence between the radial plot intersection for the point and the plotted position of the point. As many points as desired, in addition to points already mentioned, may be located by the radial plot. All points located by radial plot are transferred to the map sheet. These points are control points for the plotting of the detail.

The detail is traced directly on the map sheet from the photograph, if the photograph and the map are approximately the same scale. The photograph is placed under the map sheet with the point on the photograph directly under the radial plot position of the point. The photograph is oriented, and the detail is traced. The detail may be projected to the map sheet to the same scale as photograph or to a scale different from the photograph and traced on the map sheet. When tracing from projections some distortion due to relief and tilt of the camera axis may be eliminated.

Two measured ground control points are theoretically enough to control a planimetric map of any size area. The photogrammetric measurements are about of fourth order accuracy, or at best third order accuracy, and additional ground control points must be available to maintain fourth order accuracy location of detail to any considerable distance.

The slotted cardboard template and the slotted metal template are often used instead of the celluloid acetate template. The slotted template has a hole at the principal point. Slots of uniform width are cut along the radial lines from the principal point through each of the conjugate points, pass points and ground control points. The templates are placed with studs, representing each principal point, pass point, and control point, passing through each hole and slot represented by that stud. The studs are cylindrical tubes with outside diameter the same as the width of the slots. The templates are adjusted to make the stud representing the ground control point fall on that point as plotted to the established scale. The radial plot points are transferred to the map sheet by marking through the hole in the stud.

Relief determinations are made from a pair of overlapping photographs in the same flight strip. The photographs are placed with the radials from principal point to conjugate principal point in coincidence. The principal points are separated any desired distance. To determine the difference in elevation between point $P_1$ and point $P_2$, the distance between the two images of point $P_1$ on the oriented photographs is measured. The similar distance for point $P_2$ is measured. The difference between these two distances is p. The distance between the positions of the camera for the two exposures is measured by scaling the distance between the principal points of the two photographs on the radial plot. The difference in elevation is calculated from the formula $p = \frac{efB}{H\,(H-e)}$, where H is the height of the exposure stations above $P_1$, f is the principal distance of the camera lens and B is the distance between exposure stations for the photographs.

A view of the same object from two different points simultaneously is known as a stereoscopic view. The sense of depth perception or sense of three dimensions is due to the stereoscopic view with unaided eyes. Viewing the properly oriented overlap portion of two adjacent photographs in a flight strip gives the spatial model of the area, the same as having the eyes separated and placed at the two exposure stations. The relief of the ground is measured by making direct measurements on this spatial model. The spatial model may be observed with the unaided eye. For photogrammetric measurements the eyes are aided by the use of a magnifying lens stereoscope.

An interesting and useful application of the stereoscopic principle is the vectograph. A vectograph is prepared by placing the two overlap images of a stereoscopic pair in the area of a single image. The images polarize the light with polarization axes at right angles. The images are viewed with viewing spectacles with their polarizing lenses similarly arranged with the axis of one lens at right angles to the other. This makes only one of the vectograph images visible to each eye. The images are fused by the brain into a spatial model. The vectograph is prepared as a reflection type print, a transparency or as a lantern slide.

The modern procedure for directing the aerial camera axis does not insure that the axis is a true vertical, as assumed in this discussion. For photographs taken with the camera axis as near vertical as possible the usual radial plot may be executed with accuracy that is determined by the error in measurements, rather than the error due to tilt of the axis. Tilted photographs may be rectified if ground controls are available. The usual photogrammetric plotting machines have adjustments to eliminate errors due to tilt. The method of reconnaissance mapping with trimetrogon photography makes use of photographs with camera axis inclined sixty degrees with the vertical, nevertheless the principle of radial plot is used to compile a planimetric map from the photographs.

In conclusion, the provision of first, second, and third order accuracy control by ground survey is necessary. Photogrammetric measurements are used for supplying detail and thereby replaces the old method of plane table survey. The principles of radial plot and stereoscopic vision are the principal bases for photogrammetric measurements by ordinary hand equipment or by complicated mechanical equipment.

# ABSTRACTS

## Electronic Alternating-Current Power Regulator

L. B. CHERRY and R. F. WILD

The object of this paper is to describe an electronic alternating-current power regulator, which is instantaneous and independent of frequency.

The theory and design considerations governing a conventional circuit using gaseous discharge tubes are presented. The effect of the extent of voltage-limiting by the gas tubes on the degree of regulation is discussed.

A bridge-type circuit is described and its theory developed. The effect of the degree of unbalance of the bridge circuit on the degree of regulation is discussed. The application of these circuits for regulation of low power, particularly the use in electronic apparatus, is treated and performance data on both circuits are given.

(For complete paper see Proceedings of the I.R.E., Vol. 33, No. 4, April, 1945.)

# SECTION II. BIOLOGICAL SCIENCES

## PAPERS

### Some Marine Gastropod Shells from Puerto Rico and Mona Island

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During the twelve months from August 1944 to August 1945, the writer served as visiting Professor of Zoology in the College of Agriculture and Mechanic Arts of the University of Puerto Rico at Mayaguez, Puerto Rico. While serving there, the following Gastropod shells were collected from the beaches and tidewaters of Puerto Rico and Mona Island. The immediate locations are given for those collected from Puerto Rico. The general abundance is given by one of the following notations "Abundant," "Moderate," or "Rare." The numbers shown in parenthesis are the collectors key number. A few specimens are included from St. Thomas and St. John of the Virgin Island group.

The identifications are provided by Dr. Paul Bartsch, Curator of Mollusks, Smithsonian Institution, U. S. National Museum, Washington, D. C. The complete collection is housed in the Zoology division of the Biology Department, A. and M. College of Texas. Duplicates of those marked by the asterisk have been donated to the collection in the U. S. National Museum.

*Acmaea pustulata (Helbling) (64,67)—Condado beach, San Juan Aguadila, Boquerón, Joyuda, Paraguera, Englishtown (3 mi. So. Mayaguez), Punta Arenas (4 mi. So. Mayaguez), Mona Island (S.W. corner). Moderate

Acmaea leucopleura (Gmelin) (101)—San Juan, Mona Island. Rare.

*Diadora listeir (Orbigny) (62-102)—San Juan, Mona Island. Moderate.

*Diadora cayennensis (Lamarck) (59)—Punta Arenas (4 mi. So. Mayaguez), Joyuda, Boquerón. Moderate.

*Fissurella angusta (Gmelin) (66)—Condado beach, San Juan, Mona Island. Moderate.

*Fissurella barbadensis (Gmelin) (60)—Boquerón, Joyuda, Punta Arenas (4 mi. So. Mayaguez), Peña Cortada (Mayaguez), San Juan. Abundant.

*Fissurella nodosa (Born) (63)—San Juan, Mona Island. Rare.

*Hemitoma octoradiata (Gmelin) (61)—San Juan, Mona Island, St. John's, V.I. Moderate.

*Lucapina suffusa (Reeve) (65)—Mayaguez, Mona Island (S.W. corner). Rare.

*Chlorostoma (Omphalius) fasciata (Born) (24)—Boquerón, Mona Island, Joyuda (5 mi. So. Mayaguez), Punta Arenas (4 mi. So. Mayaguez). Shipping terminal (Mayaguez). Moderate.

*Livona pica (Linné) (14)—Coral Islands off shore from Paraguera, Punta Arenas (Mayaguez), Shipping terminal (Mayaguez). Moderate.

Tegula (Omphalius) excavata (Lamarck) (84)—San Juan. Rare.

*Turbo castaneus (Gmelin) (10)—Punta Arenas (Mayaguez), Joyuda (So. of Mayaguez), Paraguera, Boquerón.

*Astraea (Lithopoma) caelata (Gmelin) (13)—Ratones Island (offshore from Joyuda), Punta Arenas (So. of Mayaguez), Escombron Beach at San Juan. Moderate.

*Astraea (Lithopoma) tuber (Linné) (57)—Aguadilla, Quabradillas, Isabela. Rare.

*Astraea (Lithopoma) brevispina (Lamarck) (54)—Joyuda (So. of Mayaguez), Punta Arenas (So. of Mayaguez). Moderate.

Chondropoma sp. (96)—Mona Island. Rare.

*Nerita tessellata Gmelin (38)—Boquerón, Joyuda, Punta Arenas (Mayaguez), Peña Cortado (Mayaguez), Shipping terminal (Mayaguez), Paraguera, San Juan, Mona Island. Abundant.

*Nerita versicolor Gmelin (40)—Shipping terminal. (Mayaguez), Aguadilla, Anasco, Paraguera, San Juan, St. John's, V.I. Abundant.

*Nerita peloronta (Linné) (41)—Punta Arenas (Mayaguez), Quebradillas, Isabela, Escombron Beach San Juan, Paraguera. Moderate.

*Smaragdia viridis (Linné) (39)—Joyuda and north, Condado beach San Juan. Moderate.

*Neritina Virginea Linné (26a)—Joyuda and northward, Punta Arenas (4 mi. So. Mayaguez), Shipping terminal (Mayaguez), St. Thomas, V.I. Moderate.

Epitonium venosa (Sowerby) (86)—Punta Arenas or Joyuda (So. of Mayaguez). Rare.

Epitonium clathrus (Linné) (95)—San Juan. Rare.

*Naticarius canrena (Linné) (44)—Joyuda (Rat Island), Punta Arenas (So. of Mayaguez), Shipping terminal (Mayaguez). Moderate.

*Polinices lactea (Guilding) (44a)—Punta Arenas (So. of Mayaguez), Aguadilla, San Juan, Mona Island. Rare

*Sinum (Sigaretus) maculatum (Say) (45)—Bouqerón, Punta Arenas (Mayaguez), Shipping terminal (Mayaguez). Rare.

Crucibulum sp (cup and saucer)—Mona Island. Rare

Capulus sp. (Hungarian cap)—Mona Island. Rare.

*Hipponix antiquata (Linné) (71)—Aguadilla, San Juan, St. John's, V.I., Mona Island. Moderate.

*Crepidula aculeata (Gmelin) (55)—Punta Areans (So of Mayaguez), Boquerón. Moderate.

*Torinia canalifera (C. B. Adams) (73)—Punta Arenas (Mayaguez). Rare.

Torinia cylindrica (Gmelin) (92)—Punta Arenas (Mayaguez). Rare.

*Architectonica granulata (Lamarck) (53)—Aguadilla, Punta Arenas (Mayaguez), Shipping terminal (Mayaguez). Rare.

*Xenophora conchyliophora (Born) (27)—Punta Areans (Mayaguez), Shipping terminal (Mayaguez). Moderate.

*Littorina ziczac (Gmelin) (37)—Punta Arenas (Mayaguez), Peña Cortado (Mayaguez), Paraguera, Condado Beach at San Juan. Abundant.

*Littorina angulifera Lamarck (18)—Paraguera on Mangrove roots. Joyuda, Punta Arenas (So. of Mayaguez). Moderate.

*Tectarius muricatus (Linné) (16)—Peña Cortado (Mayaguez), Between Quadradillas and Isabela, Paraguera, San Juan, Mona Island. Abundant.

*Modulus modulus (Linné) (72)—Punta Areansa (So. of Mayaguez), Boquerón. Abundant.

*Turritella variegata (Linné) (17)—Joyuda, Punta Arenas (So. of Mayaguez), Shipping terminal (Mayaguez), Bouqerón. Very abundant.

Thericium literatum (Born) (89)—Punta Arenas (Mayaguez) or Joyuda. Rare.

Thericium algicola C. B. Adams (90)—Punta Arenas (Mayaguez) or Joyuda. Rare.

Thericium variabilis (C. B. Adams) (108)—Punta Arenas (Mayaguez). Rare.

*Thericium floridanum (Mörch) (12)—Boquerón, Paraguera, Joyuda, Punta Arenas, Shipping terminal (Mayaguez), Mona Island. Abundant.

*Latirus infundibulum (Gmelin) (8)—Joyuda (So. of Mayaguez). Rare.

*Nitidella hendersoni (Dall) (68)—Peña Cortado, (Mayaguez) on rocks. Moderate.

*Nitidella nitidula (Sowerby) (70 & 87)—Paraguera, Aguadilla, Shipping terminal (Mayaguez), San Juan. Moderate.

*Vermetus (Petaloconchus) irregularis varians (Orbigny) (69)—Boquerón, Punta Arenas (So. of Mayaguez), Shipping terminal (Mayaguez), San Juan, Mona Island. Moderate.

*Vermetus (Petaloconchus) sp. (69a)—Location not definite.

Pyramidella dolobrata (Linné) (88 & 94)—Punta Arenas (So. of Mayaguez), Mona Island. Rare.

*Strombus gigas Linné (28)—Paraguera, Joyuda (5 mi. So. of Mayaguez), Shipping terminal (Mayaguez). Moderate.

*Strombus pugilis Linné (29,32,91)—Shipping terminal (Mayaguez), Peña Cortado. Abundant.

*Strombus raninus Gmelin (21,106,107)—Shipping terminal (Mayaguez). Rare.

Strombus costatus Gmelin (106a)—Joyuda (5 mi. So. of Mayaguez). Rare.

Pterocera sp.—Punta Arenas (4 mi. So. of Mayaguez). Rare.

*Cypraea zebra Linné (46,100)—Punta Arenas (Mayaguez), Shipping terminal (Mayaguez). Rare.

*Cypraea cinerea (Gmelin (46a, 47)—Anasco, Punta Arenas (So. of Mayaguez), Shipping terminal (Mayaguez), Mona Island. Moderate.

*Trivia pediculus (Linné) (50)—Joyuda (So. of Mayaguez), Punta Arenas (So. of Mayaguez), Shipping terminal (Mayaguez), Mona Island. Moderate.

*Cyphoma gibbosa (Linné) (43)—Joyuda, Punta Arenas (So. of Mayaguez), Shipping terminal (Mayaguez), Mona Island. Moderate.

*Tonna perdix (Linné) (52)—Mayaguez, Mona Island. Rare.

*Cassis tuberosa (Linné) (7)—Joyuda (So. of Mayaguez), Punta Arenas (So. of Mayaguez), Mona Island. Rare.

*Cassis flammea (Linné) (42)—Mona Island. Rare.

*Cypraecassis testiculatus (Linné) (33, 100a)—Anasco, Escombron Beach San Juan, Mona Island, (S.W. corner). Moderate.

*Semicassis (Tylocassis) granulatum (Born) (34)—Peña Cortado (No. of Mayaguez), Englishtown (So. of Mayaguez), Shipping terminal (Mayaguez), Anasco, Mona Island. Moderate.

*Cymatium femorale (Linné) (2)—Punta Arenas (So. of Mayaguez), Shipping terminal (Mayaguez). Moderate.

*Lampusia martinianum (Orbigny) (4,5,103)—Shipping terminal (Mayaguez). Rare to Moderate.

*Chicoreus pomum (Gmelin) (19)—Joyuda and Rat Island (So. of Mayaguez), Shipping terminal (Mayaguez), Anasco. Moderate.

*Chicoreus brevifrons (Lamarck) (20)—Shipping terminal (Mayaguez). Rare.

*Purpura (Thais or patellipurpura) patula (Linné) (15b)—Peña Cortado (No. of Mayaguez), Mona Island. Rare.

*Leucozonia ocellata (Gmelin) (15a)—Anasco, Paraguera, Peña Cortado (Mayaguez), San Juan, Mona Island. Abundant.

Leucozonia cingulifera (Lamarck) (98)—Boquerón. Rare.

*Charonia tritonis nobilis (Conrad) (58)—Paraguera, Joyuda (So. Mayaguez), Mona Island. Rare.

Tritonocanda (Guttumium) tuberosa (Lamarck) (93)—Punta Arenas or Joyuda (So. of Mayaguez). Rare.

*Distorsio reticulata (Link) (30)—Shipping terminal (Mayaguez) Anasco. Moderate.

*Ranella cubaniana Orbigny (6)—Shipping terminal (Mayaguez). Rare.

*Fasciolaria tulipa Linné—(3)—Joyuda and Rat Island (So. of Mayaguez), Punta Arenas, Shipping terminal (Mayaguez), Peña Cortado (No. of Mayaguez). Moderate.

*Nassarius ambigua (Montago) (74)—Punta Arenas (So. of Mayaguez), Englishtown (So. of Mayaguez), Paraguera, Mona Island. Rare.

Nassarius vibex (Say) (76)—Failed to record locality. Rare.

*Columbella mercatoria (Linné) (51)—Boquerón, Punta Arenas, (So. of Mayaguez), Shipping terminal (Mayaguez), San Juan, Mona Island. Abundant.

Mitra (Scabricula) nodulosa (Gmelin) (81)—Mona Island. Rare.

*Mitra (Scabricula) barbadensis (Gmelin) (35)—Mona Island. Rare.

*Oliva reticularis (Lamarck) (31)—Punta Areans (So. of Mayaguez), Shipping terminal (Mayaguez), San Juan. Moderate.

*Olivella mutica (Say) (56)—Punta Arenas, (Mayaguez), Mona Island. Rare.

*Conus verrucosus (Hwass) (22)—Punta Arenas (4 mi. So. of Mayaguez). Abundant.

*Conus spurius (Gmelin) (23)—Punta Arenas, (So. of Mayaguez), Mona Island. Moderate.

*Conus mus (Hwass) (36)—Aguadilla, San Juan, Mona Island. Moderate.

*Conus regius (Gmelin) (75)—Punta Arenas (So. of Mayaguez), Mona Island (S.W. corner). Rare.

Actaeon ? exigus Mörch (82)—Punta Arenas (4 mil So. of Mayaguez). Rare.

*Bulla occidentalis (C. B. Adams) (48)—Mona Island. Abundant.

*Bulla amygdali Dillwyn (49)—Boquerón, Joyuda (So. of Mayaguez), Punta Arenas (So. of Mayaguez), Shipping terminal (Mayaguez). Abundant.

*Melampus monilis (Bruguière) (25)—Punta Arenas (So. of Mayaguez), Aguadilla, Escombron Beach San Juan. Rare.

Morula nodulosum (C. B. Adams) (78, 97)—Punta Arenas (So. of Mayaguez). Rare.

Engoniophos unicinctus (Say) (79,99)—Boquerón, Punta Arenas (So. of Mayaguez), Englishtown (So. of Mayaguez), San Juan. Rare.

Tropicorbis riisei (Dunker) (104)—Failed to record exact locality. Rare.

Pyrene ovulata (Lamarck) (80)—Punta Areans (So. of Mayaguez). Rare.

Pisiania plumulata (Gmelin) (101a)—San Juan, Mona Island. Rare.

*Crassispira sp. (11)—Punta Arenas, Englishtown (So. of Mayaguez). Rare.

Hojeda sp. (105)—Exact locality not recorded. Rare.

Bulimulus diaphanus (Pfeiffer) (85)—Punta Arenas (So. of Mayaguez). Rare.

## Some Penalties of Over-specialization

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The day was warm, but the road crew worked industriously. Made up of vigorous young fellows in blue denim, and under the supervision of a bright young foreman, the boys were cutting a grade along a clay bank. On a trout stream not far away was another crew, similarly dressed, and like the first, directed by a clever young technician from the State College. This group was energetically constructing dams and shelters for the benefit of the valuable fish resources, although, unfortunately, the runoff from the clay bank in process of excavation by the first crew was such that it insured a permanent roiling up of the trout stream. A little farther along a third crew, made up of recreation ground workers, was engaged in the erection along the roadside of some neat fireplaces for the picnic grounds there provided; and, lo, in the near vicinity a roadside cleanup crew gathered and burned all the down oak fuel wood which might otherwise have been available for the use of the picnickers!

Nearby was a game refuge. Here, too, several crews of healthy young stalwarts were very busy. One crew was preparing a plot for planting oats or wheat or grain sorghums for wildlife—another was cleaning up the native shrubbery and thereby unwittingly eliminating much of the game food provided by nature. All over a nearby open clover patch, incidentally the only one in the vicinity available to deer and quail, a forest crew was busily setting pines. Furthermore, a fire-line crew was systematically burning up all the hollow snags on the refuge, thereby eliminating numerous dens for mammals, as well as nesting places for woodpeckers and other birds—worse yet, they were felling the gnarled veterans, trees which were about the only scenic feature along a scenic road. "In short, the ecological and esthetic limitiations of scientific technology were revealed in all their nakedness" (Leopold, 1934, p. 540). Such crossed wires were frequent, Leopold points out, in CCC camps whose crews were directed by brainy young technicians (this was after the last war), many of them fresh from conservation schools, but each trained for a particular specialty.

It appears that in the not distant future we shall have many similar problems to cope with. In the wildlife field it is proposed to apportion through the State and the Federal Government some three hundred million dollars for restoration, rehabilitation, and development during the postwar period (only 5 percent, by the way, of the six thousand million dollars proposed to be spent for highways and reclamation projects in the same period!).

" . . . To be a practitioner of conservation on a piece of land," says Leopold, "takes more brains, and a wider range of sympathy, forethought, and experience, than to be a specialized forester, game manager, range manager, or erosion expert in a college or a conservation bureau."

All can doubtless duplicate or add to this rather sobering list of conflicts in the practical administration of conservation. One of the most spectacular was emphasized by J. N. Darling as a result of observations made during the same period of which Professor Leopold writes. When Mr. Darling was Chief of the Biological Survey of the United States Department of Agriculture the organization was given $8,500,000.00 for the reflooding of marshes and other measures for waterfowl and wildlife conservation. At the same time he pointed out that while the organization had been trying to create marshes for the benefit of muskrats, waterfowl, and other wildlife resources, other agencies, including other bureaus of the Government, had been spending still larger sums than were appropriated for the Biological Survey to dry up existing marshes. "It is cold comfort," wrote Mr. Darling, "to realize that they are doing this because they don't know any better."

No argument or sermon could be more eloquent of the need for integration, for synthesis, for the ecological approach, than some of these concrete happenings in times not so very far off. Isn't it obvious that we do need a new Declaration of Interdependence? Shall we continue to exert ourselves for conservation and rehabilitation of soil, while at the same time we permit an exploitation of the grazing range and allow cropping practices which make such recovery impossible?

Shall we erect huge dams for reclamation purposes, at large expense, and forget the watersheds above, denuded by over-grazing, with the result that silting up of the reservoirs and irrigation works proceeds at a rapid pace and may be counted on to render them useless in a relatively short period? Shall we omit to take those practical and necessary steps to hold the rainwaters where they first fall, on the very headwaters of our streams?

Shall we set up natural areas and game refuges in the mountains to regulate hunting and to build up a favorable environment for big game, when the winter range of the animals on the nearby lowlands is controlled by grazing interests that will not even consider the sale of their holdings to the Government, but insist on grazing the forage into the roots, to the ultimate destruction not only of forage plants, but also the soil, the big game, and even their own domestic livestock?

All the waste of natural resources cannot be blamed on politics. Nobody will ever know how many millions of dollars in depletion of natural resources our ultra-specilization, our water-tight compartment type of teaching and research has cost us. Perhaps it is just as well we don't know. The total would be staggering. It is poor tribute to our scientific insight and small credit to our science. What can we do to popularize a broader, more truly ecologic point of view among ourselves and our scientific colleagues?

The ecologist should be able to look out on a piece of forest land or range land or farm land or into a stream, a pond or a lake and prescribe a regimen suitable for the total situation, each biotic community in its environment, a regimen which will take full account of all the special and local conditions and result in steady improvement of the whole.

Perhaps this is asking too much of one man. But it is unreasonable to require the ecologist at least to recognize the limitations in his information, so that he will make provision to fill the gaps when he becomes responsible for lands and resources administration?

Specialists are all right, and much needed, but seemingly there is no valid why even a specialist should not try to see his problem as a whole.

Sears (1935, p. 227) points out that to an ecologist a landscape presents a great deal more than its technical details. Rather, he says, it appears as a totality, with each factor, so far as possible, considered in relation to the others. While the work of the ecologist involves analysis, of course, nevertheless, the analytical approach is only a means to final synthesis and interpretation. "*When he enters a forest or a meadow he sees not merely what is there, but what is happening there.*" Thus to the ecologist there is afforded a glimpse of the continuity, integration, and destiny which is indispensable to management and control in any real sense.

What an inspiring ideal this statement holds out to the responsible managers of land! Also to those who are charged with the responsibility of improvements in our social and economic order!

It is sometimes overlooked that one of the penalties of overspecialization may be visited on science and the scientists themselves. Ritter has clearly pointed out (Science News Letter for July 14, 1934, p. 29) that during the economic depression the tendency everywhere but in Russia has been to make science the target for economy campaigns. There is an ominous suspicion of science on the part of non-scientists. Ritter very properly attributes a large part of this attitude to the overstressing of analytic science, the kind of science that "picks things to pieces to see what makes them tick." He feels that to regain lost ground, "Science must re-emphasize the principle that analysis and synthesis are not opposed, but properly form a continuum."

Whitehead has protested the "trivialized professorial intellect" that results from the excessive specialization of the times. Treviranus, an early Greek author, is said to have considered plants and animals to be as real as any of the things of which they were composed! Why can't we regard our communities of plants and animals as real as any of the species of which they are made up?

I have suggested already some of the broad implications of the point of view here expressed. It might be pointed out also that the specialized ultracompartmentalized point of view is associated with barriers to trade, to misunderstanding, selfishness, and war; in short, the isolationist attitude, with all its threats to future world security. On the other hand, it is obvious that the bio-ecological point of view should lead to improved cooperation, free trade, more comprehensive and enlightened understanding, higher standards of living, and a world peace based on the solid foundation of adequate information, clear apprehension of the significance of the facts in their places, and, we hope, the necessary good will on the part of mankind everywhere to make the world machinery function.

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## An Experimental Refresher and Orientation Course For Medical Freshmen Students

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As a result of war conditions a continuing supply of satisfactorily trained premedical students has been very difficult to maintain. The main sources for students admitted to the School were as follows:

1. Army Specialized Training Program
2. The Naval V-12 Training Program
3. Civilian students who were
    (a) Classified as 4-F by Selective Service
    (b) Seventeen years of age at the time of admission to Medical School.
4. A few returning veterans

The AST Program offered sixty semester hours of premedical training. Naval V-12 trainees received approximately eighty semester hours, including the courses in Naval Organization. Our admission requirements for civilian students were held at a minimum of seventy-two semester hours. Many of the Army and Navy trainees and a few of the civilian students had been away from actual class contact for periods varying from three months to seven or eight years.

The above variations in degrees of preparation indicate to some extent the problem in medical education which had to be met by the Faculty of the University of Texas School of Medicine. It was decided that an orientation and refresher course of three weeks duration should be organized to give all students matriculating an opportunity to prepare themselves a bit more satisfactorily prior to the actual commencement of the first year medical courses. A battery of six examinations covering the biological and physical sciences, the use of English in the study of medicine, psychological and personality tests, and general information examinations were given to the students for three days prior to the three weeks refresher period. Data on these examinations will be correlated with the performance of the students during the three weeks period and with attainments in the curriculum of the first year in medicine.

During each week there were thirty-nine hours of instructional time scheduled. This was divided about equally into lectures, laboratory work and group and individual personal conferences with faculty members. During the conference periods particularly, every effort was made to give each individual student assistance in the phase of premedical work in which he was found to be weakest in the initial examinations given. Students were encouraged to confer with faculty members at any time regarding difficulties they might be having in their work.

Along with the refresher work indicated above every effort was made to point up for the students the importance of the premedical work as it applies to the study of medicine. This correlation was handled not only by the preclinical but by the clinical faculty in the form of clinical-preclinical sessions. At the end of the three week period an additional series of six examinations were given, supervised by the several departments, covering the work of the three weeks orientation. The scores made on this series of examinations will count towards the semester's grade in each of the several departments.

It is the general consensus of opinion both in the faculty and among the freshmen students that the experiment was a highly satisfactory one and that the results were far above expectations. With minor changes and improvements, a similar program could be made quite valuable, not only as a basis for preliminary preparation for freshmen students but also as a criterion for the selection of students for admission to medical school.

## The Case for Teaching Biological Science

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This discussion deals with attitudes. It deals with current events in Biological Science. It is somewhat of a prognosis. Its presentation here among the reports of research contributions may be justified on the basis that its implications may help to show the way for more continued contributions in succeeding generations. To look that far ahead, we must direct some attention to the boy and girl now in the secondary schools and the young men and women in our colleges and universities. We must recognize the importance of teaching in our field of science. Let us ask ourselves clearly and candidly: Do we recognize the importance of teaching in our field?

Witness, for example, a report made by a friend of ours sometime last year. This young man was consulting a prospective major professor regarding his possibilities for doing a problem for a graduate degree. He was told in effect: "Now there is one thing that you must decide. Are you going to continue to be interested in teaching; or are you going into research? If you are interested in the latter we may be able to work out something." The connotation was obvious and it brings up this significant point. Is there something wrong with being interested in teaching? Let us hasten very definitely to explain that it is not our purpose to minimize or suggest the slightest lessening in importance of research. This is not "double talk" nor is it just getting on the band wagon because in modern times research is popular. We know that tremendous contributions to human advancement have been made by the research of many specialists—specialists in Medicine, Bacteriology, Botany, Zoology, Entomology, Sanitation, Agriculture, Horticulture, Silviculture, Agronomy, Conservation, Biochemistry, Pharmacology, and many others. We give just tribute to these men and women and their contributions. Because of these contributions, Biological Science Teachers—high school, college or university—have as part of their obligation the educational combat against quackery, false science, and even modern advertising. As a result of teaching in these fields we may expect continued contributions—provided we do take a positive and not a negative attitude toward teaching.

Let us go back to this corps of specialists and consider the same problem in a different way. Each of these specialists, (be he a college professor, in industry, or with the government), went to school. His beginning in his field was guided by teachers. How many received their first spark of interest, their enthusiasm, and their determination to go into these fields from some one or more teachers somewhere down the line? But this is only part of the picture. The other part is even more thought-provoking. How many potential scientists did not go into the field because of the lack of this spark of interest and enthusiasm? What great discoveries might they have made to make better your life and mine? If we are interested in the further development of the field of Biological Science, we must be interested in teaching of the Biological Sciences. What is wrong with being interested in the teaching field? If there are any college professors in this audience, you may want to ask yourself this question: "Have I ever considered my teaching as a necessary nuisance?"

What does all of this indicate? A positive attitude toward teaching for one thing, but that has already been illustrated. It also indicates Biologists-Teachers for the lower levels and Teacher-Biologists on the higher levels.

Let us illustrate the full meaning of this contention by a study as nearly as possible of the present situation regarding the teaching of the Biological Sciences in the Secondary Schools of our State. The data compiled herein is taken from the files and bulletins of the Division of Supervision, State Department of Education. Table I is taken from the 1944-45 Bulletin: *Standards and Activities of the Division of Supervision.*

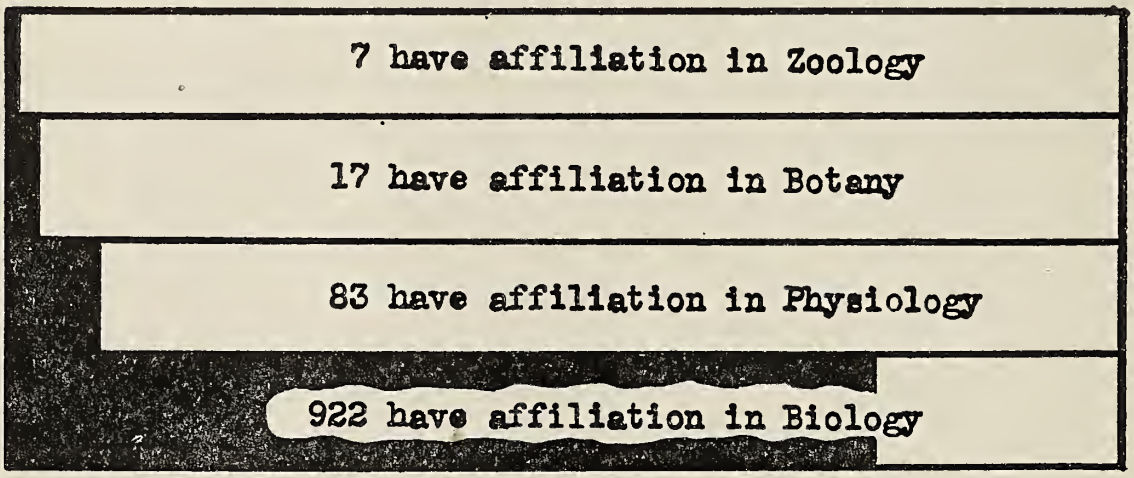

TABLE I
**Affiliation in Biological Sciences, 1237 Texas affiliated 4-year high schools, 1944-45**

For a more detailed study of the Biological Science situation, the high school membership of the Southern Association of Secondary Schools and Colleges was taken as a sample. This membership was not taken as a random sample, however, because the combined enrollment of these schools represents 54.7% of the total enrollment of the Texas 4-year affiliated high schools. It was taken because it represents nearly all of the larger schools and most of those which offer more than one or two sections of Biological Science. Data for four schools which are members of the Association was not available at the time of the study, therefore the computations included are on the basis of 268 out of the 272 members. Table II shows the number of these schools which have affiliation in the Biological Sciences.

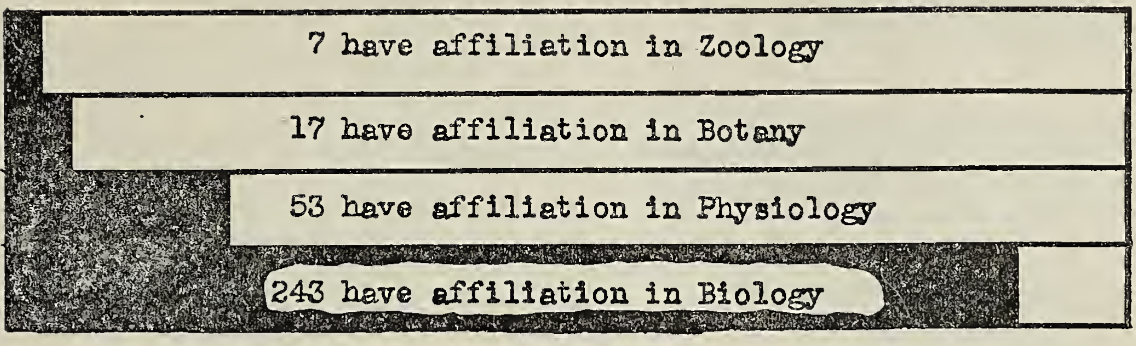

TABLE II
Affiliation in Biological Sciences, 268 Southern Association Texas high schools, 1944-45

With these data as a background, we may now turn our attention to the Biological Sciences offered in these schools. A study of their schedules shows the number which did not offer any courses in this field during the 1944-45 school year. This is illustrated in Table III.

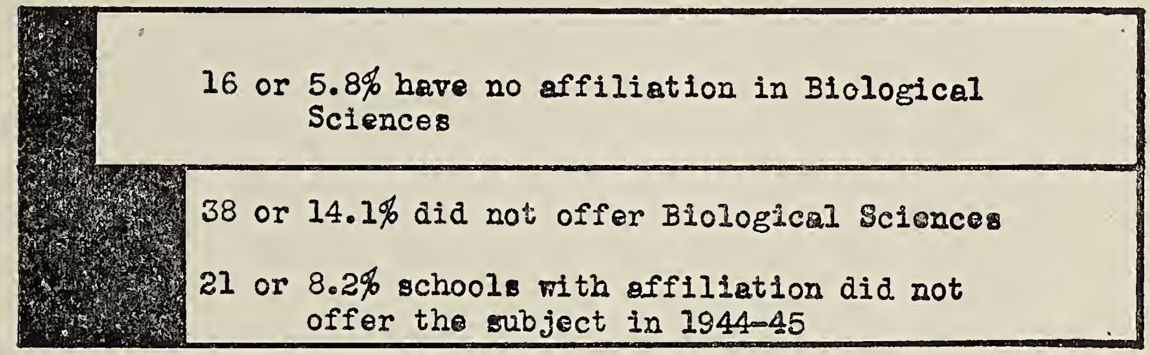

TABLE III
Number of schools not offering Biological Sciences, 268 Southern Association high schools, 1944-45

Further study of these schools shows that 306 teachers were teaching one or more sections of Biological Science. These may be tabulated as follows:

110 teaching 3 or more sections
81 teaching 2 sections
115 teaching 1 section

It should be interesting to note at this point that even in many schools where a mumber of sections were offered, they were scattered to a number of different teachers. For example, with 5 sections as a normal teaching load, 2, 3, and 4 sections taught by two teachers; 6 and 7 sections taught by 3 teachers; 11 and 12 sections taught by 4 teachers; and 16 sections taught by 5 teachers.

Since 3 or more sections constitutes the majority teaching load of a teacher and ordinarily should represent his major field of study and training, the training background of these 110 teachers was compiled. Table IV illustrates in a somewhat startling manner the results of this report.

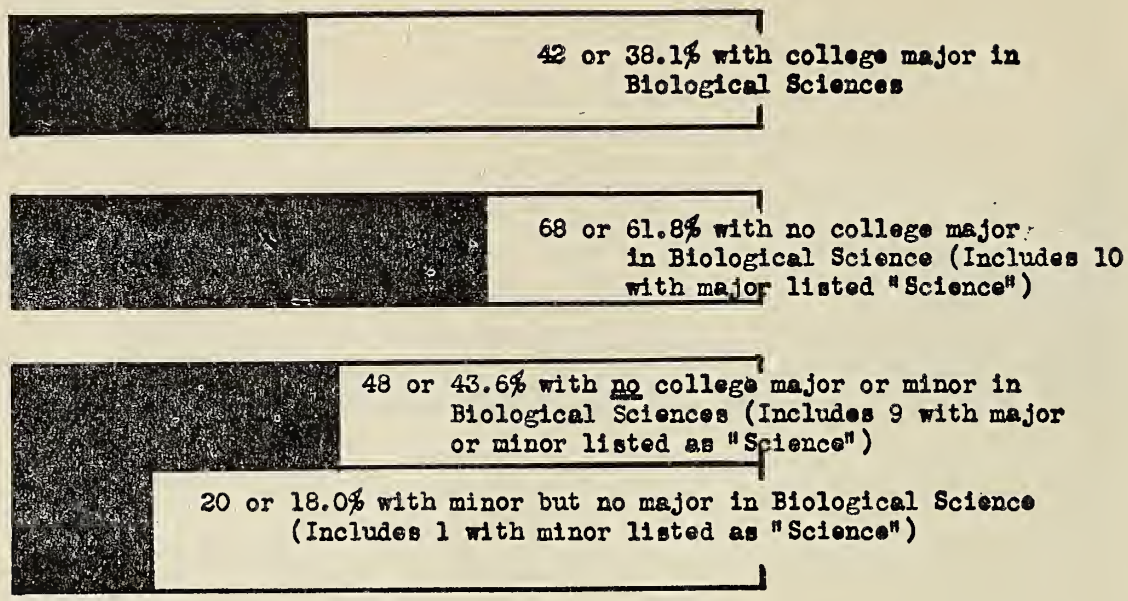

TABLE IV
110 teachers who taught 3 or more sections of Biological Science in 268 Southern Association schools, 1944-45

If 61.8% of these teachers are not Biological Science majors and 43.6% of them have no major or minor in this field, we may well wonder who is teaching the Biological Sciences. A study of this situation reveals that ten of them majored in Home Economics, 12 in Education, 8 in the Social Sciences, 8 in English, 11 in Chemistry or Physics, 3 in Physical Education, 4 in Spanish, 1 in German, 1 in Art, and 10 listed "Science" as a major. One thing is very obvious as a result of this study. We sincerely owe a debt of thanks to the teachers of Home Economics, Social Science, English, Education, Chemistry and Physics, Physical Education, Spanish, German, and Art for keeping our subject in the curriculum. And even they could not do it in 8.2% of these 268 schools as illustrated in Table III.

Since these 10 "Science" majors may conceivably have had suitable training in Biology, it may be reasonably argued that they should not be included in the percentages of "No college majors in Biological Sciences" in Table IV. As a matter of fact, for many secondary school positions, training in more than one of the sciences is very desirable and necessary. This is a point which will be mentioned later.

To continue the study of our problem, inquiries regarding the number of registered biology vacancies and applicants were made of Teacher Placement Bureaus from seventeen of the principal Senior Colleges and Universities in the State. Twelve out of the seventeen replied to the inquiry. Since some of the Bureaus recorded Biology with the other sciences and also in combination with various other subjects it is difficult to get a picture of the Biology situation as separated from other fields. Even so, some of the data which may be separated reveal a significant condition. This is illustrated in Table V, where only one school indicates filling more than half of the vacancies listed. It should also be kept in mind that the same vacancy may have been listed at several schools. For this reason each bar represents a different Placement Bureau in Table V.

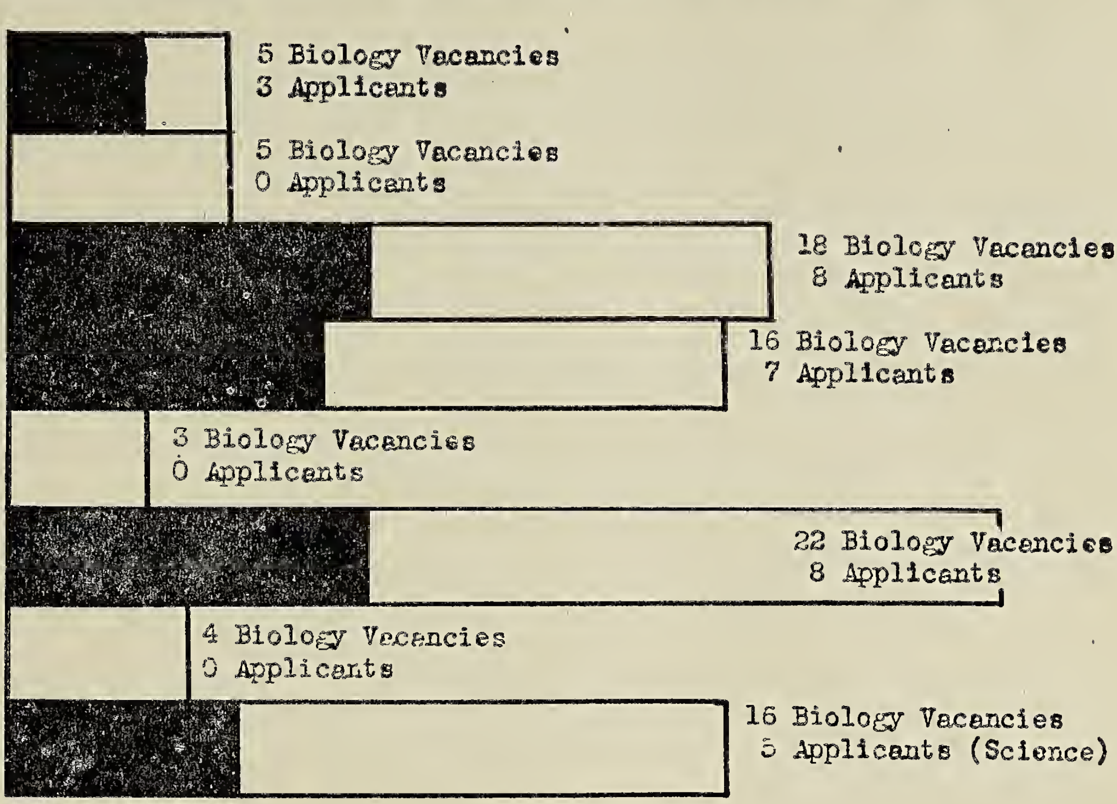

TABLE V
**Report from 8 of the principal Texas colleges and universities on Biological vacancies and applications as listed with Teachers Placement Bureaus, 1944-45**

It may be significant to quote from several of the letters received from the Placement Bureau Directors:

> "We had 152 vacancies for Science Positions listed and only 5 applicants. If the Scientists and Educators of the State do not encourage people to go into teaching in these fields, I do not know what we are going to do."
>
> "Of course, you can be certain that we placed every available teacher of Science and could have given them two or three positions and more. "
>
> "61 vacancies in Science—13 applicants."
>
> "The figures on calls for teachers may run a little high (98 vacancies in science—8 applicants), because some towns wrote us several times."
>
> "We did not keep a written record of all our calls for teachers since there are so many made in person by school officials and many by telephone. Therefore, our figures must be an approximation.
>
> In our classes of January, June, and August, we had 12 science majors which combines chemistry and biology. In breaking these down, we find 7 in biology and in chemistry 5. Our calls would approximate 350 for science. This number, of course, is the minimum and had we kept a record, doubtless we would have been surprised at the total number.
>
> Available for teaching out of our combined group of graduates, we found only 5."

It is of but little help to recognize that in times like these teachers may not register as readily with the Placement Bureaus since they cay secure positions without their services. However, there is still a big gap to fill, even on a national basis. Newspapers and Journals are devoting space to the problem. For example, the *Science News Letter*, September 29, 1945, says: "The Journal (discussing an editorial in the *Chemical and Engineering News)* calls attention to the present grave lack of trained scientists for research and teaching tasks, caused by the indiscriminate drafting of young men away from their laboratories and classrooms during the war emergency . . ."

It is also of but little help to point out that the situation described in this paper deals with the school year just concluded. We were at War then, but the War is over now. But War or no War, we must deal with what *is* and must look to and prepare for the future. The War is over and we are glad. Some of our Biology teachers will be back, but not all, and during the War few to none were trained. We still have a need for teachers and to blame it on the War is of no value toward a solution.

In spite of all of these conditions, however, pessimism is not the solution to the problem. This problem and its future deserves a much more aggressive and positive action. In this connection, the study of our present condition has a good many implications. Some of them may be summarized as follows:

(1) A positive and not a negative attitude toward teaching in our field. This includes the encouragement of capable and qualified people to go into teaching. Not everyone, of course, is suited for teaching work. Selection is desirable, but not the kind of selection that encourages into teaching only those who cannot qualify for other work.

(2) Good training in both the Biological Sciences and Teaching —all the way from the secondary schools through the colleges and universities.

(3) Currciulum adjustments for both secondary schools and colleges are definitely indicated. On the high school level, science for life (Biology, Chemistry, Physics, etc.), not just for college preparation is needed. Too many of our high school boys and girls do not go to college. Curriculum adjustments on the college level should develop science courses (Biology, Chemistry, Physics, etc.) to train people to teach this kind of subject matter. Some extensive as well as the intensive courses are indicated. Courses in Science Education taught by people trained in Sciences and Teaching Methods should be considered. In a large number of the schools one section each in General Science, Biology, Chemistry, and Physics is offered. College curriculum consideration of this condition is needed. This is what we mean when we stated earlier in the discussion that a major in "Science" might be desirable for many positions.

(4) This study indicated the need for the restoration and revitalization of our subject in the schools. This same idea was expressed to the Texas Academy of Science in 1943 in a speech by

Dr. C. C. Doak, head of the Biology Department at Texas Agricultural and Mechanical College. Dr. Doak said: "The restoration and revitalization of both high school and college science, to say nothing of the science of the pulpit and press, is imperative. We must recognize the fact that no man is equipped to live out his life to the fullest unless he has some training in scientific method, and no society can coordinate its behavior in a scientific age unless its members have given some thought to Biology, which, after all, is but the science of life. This statement is not meant to lessen in any way the importance of the other sciences for they, like Biology, have been poorly taught, neglected, and impoverished."

(5) This study indicates the need for a more careful examination of reasons, other than the War, why the number of teachers for Biology and other sciences is inadequate. The attitude of some of the scientists who train them may be one reason. Disadvantages characteristic of the teaching profession may be another. It should be remembered, however, that there are some disadvantages to any profession, and that while there are disadvantages to teaching, it also has its compensations.

In the final analysis it should be obvious that the Biologists have a big job to do: Research; production and maintenance of materials needed for the existence and comforts of life; and teaching. It is teaching that helps to get man to that periphery of knowledge to where production and maintenance, and research can begin. All are necessary for progress.

The old saying that "those who can, *do;* those who *can't,* teach" is a lot of "bunk." *Teaching is doing!*

## Four Years Experience With Basal Body Temperature Techniques in Gynecology

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Basal body temperature (BBT) in women of reproductive age usually follows a predictable course, with a gradual fall, and low level, until 13 to 15 days before the time for the next menstruation. There is then a rather sharp rise to a plateau which continues until a day or so before the flow starts, when the decline in temperature begins again. The premenstrual phase is relatively constant in length, but the postmenstrual phase varies with the length of the cycle.

The BBT cycle has been correlated by other workers with the ovarian cycle, hormone levels, sex hormone effects such as endometrial proliferation, transformation and glycogen content, Mittelschmerz, intermenstrual bleeding, breast changes, and even the psychodynamic cyclic changes. Also, the time of ovulation has been found to be relatively constant in regard to the sharp rise in BBT.

On the basis of these reports, advice was given to Sterility Clinic patients in whom no outstanding anatomic or pathologic causes for sterility were found, concerning the days on which intercourse would be most likely to result in pregnancy. Consecutive-day data and charts were used to follow progress and as a basis for advice on future procedure. BBT was also used as an adjunct in contraceptive advice when this was indicated, and when religious scruples, prejudices and training made more tangible methods inapplicable. It was found that BBT records aid in timing intercourse (and particularly artificial insemination, when this is necessary) properly for fertility, and that functional sterility due to improper timing can be overcome by BBT studies. Such studies include data on frequency and timing of intercourse, and thus serve as a check on statements in the history regarding this factor. Where there is a discrepancy, the data aid in an understanding of the case.

By BBT data it has been demonstrated that estrogen administration can inhibit ovulation for that cycle. In women taking BBT data it is possible to diagnose pregnancy before the Friedman test becomes positive. BBT data would be useful in timing early embryos in experimental human embryology. Study of BBT data has proved valuable in the work-up of patients having retarded sexual development, amenorrhea, menorrhagia, dysmenorrhea, suspected anovulatory cycles, or threatened abortion, as well as in following the results of therapy. When the patient is irregular, and it is desirable to know beforehand when menstruation will occur, BBT is of value in predicting the date, as well as being an aid in the timing of some diagnostic procedures, such as endometrial biopsy, tubal insufflation, or the Huhner-Weisman test. BBT is also a check on the endometrial biopsy findings.

The procedure is simple, quick, inexpensive, uncomplicated, and accurate enough (as reliable as estrogen assay or endometrial biopsy. It has been adopted recently by many physicians and by the Planned Parenthood Federation of America as a standard procedure. Limitations in the accuracy and usefulness of the procedure are: 1) cooperation of the patient (which depends primarily on motivation), 2) mentality of the patient, and 3) thorough understanding and notation in the data of other possible reasons for thermal shift, such as coryza, or a poor night's sleep.

## Ascorbic Acid Metabolism of Fifty College Students

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The chemical isolation and purification of ascorbic acid have encouraged some new approaches to the estimation of the human vitamin C requirement. At the present time there are three yardsticks in use, singly or in combination, for arriving at ascorbic acid standards. These are: (1) the capillary-resistance or fragility test, which measures the strength of the capillaries; (2) the determination of the ascorbic acid content of urine, which measures the amount of vitamin C excreted and, in connection with a knowledge of the vitamin C content of the foods eaten or consumed shows how much has been used or lost from the body; and (3) the determination of the ascorbic content of the blood, which shows how much of the vitamin is ordinarily in circulation.

The importance of ascorbic acid excretion lies in the assumption that it may be used as an index of ascorbic acid saturation. According to this assumption, the resting level, that is, the average daily excretion of ascorbic acid on a normal diet, may indicate the condition of the tissues in regard to saturation with ascorbic acid, while the determination of urinary excretion after a test-dose gives further information in this respect. The theory is that if a large percentage of the test-dose is excreted, the tissues are saturated and hence do not retain the extra ascorbic acid. If one takes for granted that "saturation" represents the maximum utilization of ascorbic acid, the degree of saturation may be taken to represent the state of ascorbic acid nutrition of an individual. Consequently, much of the experimental work has been directed toward the methods of determining saturation. These methods fall into two groups: first, methods in which the urinary ascorbic acid after a single test-dose of the vitamin is measured, and second, methods in which the length of time required to excrete a certain percentage of a given daily test-dose is determined.

Hawley, Stephens and Anderson (1936) confirmed the results of Johnson and Zilva (1934) that normal adults on an average diet excreted from 15 to 30 mg. of vitamin C daily and that when a large test-dose was administered to such individuals that a prompt and marked increase in urinary output resulted. On the other hand, when a test-dose was administered to patients with scurvy, or to those with a history of vitamin C underfeeding, the urinary excretion remained low. Thus it was suggested that the urinary excretion of ingested vitamin C was an index to the degree of saturation and might be used as a test for bypovitaminosis C.

Todhunter and Post (1937) studied the ascorbic acid excretion of urine in 7 college women for 2 to 6 days. Two whose diets contained little fruit or vegetables excreted 10.6 to 14.6 mg. daily; two whose diets included some fruit and vegetables excreted 29.3 to 23.7 mg. daily; three with high intakes of fruit juices, fresh salad and vegetables excreted 42.6, 60.2, and 83.7 mg. daily. In a similar study of eight normal women, Toverud (1937) estimated the daily excretion of ascorbic acid to range from 15.8 to 53.9 mg. After a dose of 250 mg. of ascorbic acid, 50 percent or more was excreted in the urine in the first 24 hours, indicated saturation in the group of eight.

Inseparable from the problem of determining the normal minimal excretion of ascorbic acid is the problem of determining the daily requirement of ascorbic acid intake necessary to maintain that output value.

Harris, Abbasy and Yudkin (1936) determined the daily requirement of ascorbic acid by tests on control subjects. Groups of six adults were placed on diets low in vitamin C, followed by a strict scurvy-producing diet, entirely devoid of all vitamin C, until their reserves had fallen to a markedly subnormal level, as indicated by resulting low urinary output on a vitamin C-free diet. The daily excretion thereupon gradually rose and finally, after about 42 to 49 days, became steady at 13 to 14.5 mg. When this steady state had been reached, a good response on either the first or second day followed the administration of test-doses of 700 mg. Thus, it appeared that if the subject excreted less than 13 mg. per day and failed to respond on the first or second day to a test-dose of 700 mg., it is presumed that his diet has contained less than the reputed minimum (25 mg.) of ascorbic acid. The response to a test-dose was proportional to the resting level under ordinary circumstances. Then one might make the observation that the daily requirement of ascorbic acid ranges from a minimum of 25 mg. to an optimum of actual requirement of 60 mg. per day. The National Research Council recommends 70 mg. for adult women and 75 mg. for adult men per day.

Corlette, (1936), estimated the degree of saturation by giving large amounts of ascorbic acid, in most cases over 400 mg., in divided doses during a 12-hour period. Four subjects were studied over a long period on vitami C-free diets with varied additions of the vitamin. The results indicated that complete saturation was quickly lost, but that the degree of saturation on diets containing a reasonably liberal amount of vitamin C was greater than on diets relatively low in vitamin C. As a result of these tests, the excretion of at least 30 percent of a good-sized test-dose within 24 hours was adopted as the lower limit of normal saturation. The results of Vauthey (1938) were in close agreement with those of Corlette; in normal subjects, 28 to 29 percent of the massive dose was excreted within 24 hours by saturated subjects.

Extensive studies of the ascorbic acid metabolism of college students in the Northwest and Northeast have been, and are being, carried on. Only a few such studies have been made in the Southwest. In these studies a resting level of 15 mg. and a 30 percent return of a test-dose have been widely used to denote normal ascorbic acid nutrition. Thus, the object of the present study was to determine the status of the ascorbic acid metabolism of a group of college women, using the above criteria and comparing the results with those obtained in Texas and in other sections of the United States, thus extending the studies in the Southwest.

## PROCEDURE

The procedure of this study was essentially the same as that followed by Metcalfe (1940) and Steinkamp (1941) in their studies of a group of freshman nurses and a group of college women for ascorbic acid metabolism as determined by urinary excretion levels and the response to a test dosage of ascorbic acid.

The study was made of a group of fifty North Texas State Teachers College women between the months of April and July, 1943, inclusive. Forty-four of the subjects were home economics majors and had had some training in nutrition. The age range was 17 to 40 years.

No collections were made during or near the approach of the menstrual period because of an increased ascorbic acid content of the urine at that time as shown by Fernandes (1939).

Each subject was given a record sheet and instructed to keep a daily dietary for seven days of all foods known to contain appreciable amounts of ascorbic acid with the approximate amounts eaten. A list of suggested foods was incorporated in the record sheet. The record was kept for three days prior to and for the four days during the urine collection period, in order that the approximate average daily intake of ascorbic acid might be calculated. All possible information concerning age, height, weight, activity, perspiration, recent illnesses and use of drugs was obtained from each subject, as each factor influences the ascorbic acid metabolism.

The subjects were divided into groups of six or eight and given instructions for urine collections. On the first morning of the collection period, the bladder is to be emptied on rising, and all urine throughout the remainder of that day until the same time the second morning is to be collected. The second day's sample is then begun, and the second and third samples collected in the same manner. On the morning of the fourth day, the subjects upon rising, receive a single dose of 300 mg. of pure ascorbic acid and the 24-hour urinary specimen is then collected in the same manner as for the three preceding days. Each morning, the samples are brought to the laboratory to be tested for ascorbic acid content.

The urine was collected in wide-mouth, 4-liter amber bottles containing the following amounts of a preservative recommended by Sendroy and shown by Metcalfe (1940) to be the most effective for preserving the urine: .75 ml. of 5N $H_2SO_4$, 5 ml. of toluene, and 1 ml. of 8-hydroxyquinoline (1.45 gm. of hydroxyquinoline in 100 ml. of 95% alcohol). The bottles remained at room temperatures at the residence of the subject during the period of collection, but aliquot portions of each sample were placed in the refrigerator as soon as they were brought to the laboratory, unless they were titrated immediately. The method of determining the ascorbic acid content of urine was a modification of Tillman's original method as used by Metcalfe (1940). The dye was standardized daily against a solution of pure ascorbic acid containing 10-0.1 mg. of ascorbic acid per 100 ml. of 3% metaphosphoric acid solution.

The 24-hour samples were measured by means of a liter graduated cylinder and an aliquot portion of each was filtered through qualitative filter paper into a 50-ml. Pyrex test tube. The tubes were placed in the refrigerator until the contents were titrated. Three determinations on each sample were made and the average reported as the ascorbic acid content of the sample.

The "resting level" excretion of ascorbic acid for each subject was determined by an average of the excretion values for the first three days of urine collection. The saturation level was determined by the percentage return of the 300-mg. test-dose. According to

Corlette, *et al.,* (1936) a return of 30 percent of a good-sized test-dose within 24 hours represents the lower limit of normal tissue saturation.

All equipment used throughout the experiment was carefully washed with cleaning solution ($K_2Cr_2O_7$ and concentrated $H_2SO_4$), followed by a thorough rinsing with tap water, then by at least five rinsings with water which had been re-distilled in glass equipment after being previously distilled in a standard copper still. The distilled water was highly colored with $KMnO_4$ when placed in the glass distilling flask in order to oxidize any remaining volatile organic and inorganic substances which would otherwise oxidize the ascorbic acid. All reagents and solutions were prepared with glass re-distilled water.

## DISCUSSION OF RESULTS

Different resting levels of urinary excretion (the average of the amount of ascorbic acid excreted over a period of several days on a normal diet) have been suggested as standards below which an individual cannot fall without being considered in a state of ascorbic acid subnutrition and different percentage returns of test-doses have been considered indicative of tissue saturation. However, in the extensive studies made throughout the United States, more particularly in the Northeast and the Northwest, the most widely used figures have been a resting level of 15 mg. and a 30 percent return of a test-dose of ascorbic acid. These standards are used in evaluating the data obtained in this study.

The day-by-day intake as well as the average daily intake of ascorbic acid, together with the resting level excretion is given for each of the fifty North Texas State Teachers College women who served as subjects in this study. The values of each daily dietary were calculated from the approximate amounts of food eaten each day during the three days prior to and the four days of the test period. Munsell's (1943) table on the ascorbic acid content of foods was used. These estimated values do not possess a great degree of accuracy due to the difficulty in estimating the exact amounts of the foods eaten, the variation in the ascorbic acid content of the different samples of the same food, the variance in the amount of ascorbic acid lost in cooking, and the fact that inevitably some subjects omit some foods from the dietary. Consequently, the estimated ascorbic acid intake is only given here for reference purposes and not for its authenticity.

The ascorbic acid values for resting level and percent return after a test dose are given in the three tables, 1, 2, and 3. These are the three living groups represented by the subjects in this study. Table 1 includes the 15 living in the home management house. These girls are all home economics majors and classified as seniors. There seems to be no relationship between the home, rural or urban, of these subjects and their resting level of ascorbic acid. This is also true of the subjects in the other living situations (Tables 2 and 3). The home management house group is the only

### TABLE I

**Resting Level and Test Dose Returns of Ascorbic Acid of College Women Living in the Home Management House**

| Subjects | | Ascorbic Acid Intake | Urinary Excretion of Ascorbic Acid | | |
|---|---|---|---|---|---|
| No. | Home | | Resting levels | Test dose returned | Test dose returned |
| | | mg. | mg. | mg. | % |
| 1 | r | 42.2 | 12.2 | 133.5 | 40.4 |
| 2 | r | 84.9 | 16.7 | 102.2 | 28.5 |
| 3 | r | 95.3 | 19.3 | 191.3 | 57.5 |
| 4 | r | 51.4 | 20.2 | 187.3 | 55.7 |
| 5 | u | 53.0 | 23.6 | 65.2 | 14.2 |
| 6 | u | 106.0 | 24.6 | 161.3 | 45.6 |
| 7 | u | 54.9 | 26.7 | 96.2 | 23.1 |
| 8 | u | 91.4 | 34. | 200.7 | 55.4 |
| 9 | u | 97.4 | 38.0 | 147.0 | 36.4 |
| 10 | u | 56.4 | 40.4 | 216.5 | 58.7 |
| 11 | u | 84.7 | 44.0 | 152.5 | 36.1 |
| 12 | u | 84.2 | 49.0 | 139.3 | 30.1 |
| 13 | u | 89.1 | 50.0 | 239.1 | 63.0 |
| 14 | u | 106.0 | 57.0 | 147.0 | 30.0 |
| 15 | u | 93.6 | 80.2 | 15.5 | 11.8 |

one with just one subject giving a resting level below saturation, using 15 mgs. as the minimum saturation point, although four of them did not return 30 percent or more after the test dose. All of these subjects had been living in the home management house for a period of a month prior to their participation in this study. One of the purposes of the home management house is to put into practice the food practices which they have learned about in their foods and nutrition courses. Their menus are always checked by the director of the house before they are prepared. There is no doubt but that the variety and quantity of food served is superior to that ordinarily selected by or served to students.

Table 2 shows the resting and test dose returns of the sixteen women living in dormitories or cooperative college houses all of which have a trained person planning and directing the preparation of the food. There is no way of seeing to it that all of the girls consume all of the food prepared for them nor of eating some of all of the foods served. Therefore, the food consumed by these girls undoubtedly shows less consistency than that obtained by the girls in Table 1. These differences cannot be attributed to seasonal variations in diet since the study was completed within a four months period of time. Mitchell and Merrim (1938) observed higher values in the spring than in the fall of the year in their study in the Northeast. Nine of these girls in Table 2 had less than the 15 mg. resting level and 12 returned less than 30 percent of the test dose. Subject No. 10 had had a temperature as the result of a typhoid shot given in connection with a biology course. No explanation for the other two negative returns (subjects 4 and 8) were available.

## TABLE II

### Resting Levels and Test Dose Returns of Ascorbic Acid of College Women Living in Dormitories and Cooperative Houses

| Subjects | | Ascorbic Acid Intake | Urinary Excretion of Ascorbic Acid | | |
|---|---|---|---|---|---|
| No. | Home | | Resting levels | Test dose returned | Test dose returned |
| | | mg. | mg. | mg. | % |
| | | | DORMITORIES | | |
| 1 | r | 72.5 | 12.0 | 87.1 | 25.0 |
| 2 | r | 69.0 | 12.5 | 35.5 | 7.7 |
| 3 | r | 92.4 | 14.0 | 63.6 | 16.5 |
| 4 | u | 61.6 | 14.5 | 10.8 | (–) 1.2 |
| 5 | u | 68.7 | 14.5 | 57.9 | 14.5 |
| 6 | r | 78.4 | 14.6 | 19.7 | 1.7 |
| 7 | u | 39.9 | 14.8 | 74.4 | 19.9 |
| 8 | u | 62.7 | 15.6 | 11.1 | (–) 1.5 |
| 9 | r | 118.1 | 17.0 | 256.8 | 80.0 |
| 10 | u | 108.9 | 20.8 | 19.2 | (–) 0.5 |
| 11 | u | 94.0 | 22.1 | 271.5 | 83.1 |
| 12 | r | 114.6 | 31.9 | 190.1 | 52.7 |
| | | | COOPERATIVE HOUSES | | |
| 1 | u | 40.4 | 14.1 | 49.6 | 11.9 |
| 2 | r | 69.3 | 14.7 | 17.3 | 0.9 |
| 3 | u | 87.0 | 16.5 | 58.2 | 13.9 |
| 4 | r | 56.9 | 27.3 | 207.7 | 81.1 |

Both the fasting and test dose returns were much less than those for the home management house girls. These were home economics majors also but of less than senior standing.

The nineteen girls living at home or in private homes are shown in Table 3. It is evident that both the resting and test dose returns are intermediary between the two previously mentioned groups. Seven showed a low fasting level and ten failed to show saturation after the test dose. Number 19 was the only girl in the study who was taking ascorbic acid regularly and she gave the highest resting level as well as the highest return of the test dose. The six non-home economics majors were lowest of this group.

Using the 15 mg. resting level as the criterion for ascorbic acid saturation the Northwest group of college students reported by Fincke (1940) 16.7% of the Montana, 26.7% of the Utah, 22.0% of the Oregon, and 2.1% of the Washington women unsaturated. This represents approximately 17% of the Northwest college women as compared to 34% from North Texas State Teachers College. The University of Texas unpublished study (Conducted during the same period as the latter study, April through July, but during 1940-41.) of college women showed 64.1 unsaturated by this same criteria. This percent is higher than that reported for Massachusetts college students (50.7). This Texas group shows greater unsaturation

## TABLE III

### Resting Level and Test Dose Returns of Ascorbic Acid of College Women Living in Private Homes

| Subjects | | Ascorbic Acid Intake | Urinary Excretion of Ascorbic Acid | | |
|---|---|---|---|---|---|
| No. | Home | | Resting levels | Test dose returned | Test dose returned |
| | | mg. | mg. | mg. | % |
| 1 | u | 65.1 | 9.7 | 9.8 | 0.0 |
| 2 | r | 66.6 | 10.9 | 10.3 | 0.2 |
| 3 | u | 114.3 | 12.4 | 15.4 | 1.0 |
| 4 | r | 32.6 | 13.4 | 17.4 | 1.3 |
| 5 | r | 40.6 | 13.5 | 10.7 | 1.0 |
| 6 | u | 65.1 | 14.4 | 15.5 | 0.4 |
| 7 | u | 7.0 | 14.5 | 140.2 | 41.9 |
| 8 | r | 67.0 | 15.7 | 36.9 | 7.1 |
| 9 | u | 73.3 | 15.9 | 121.2 | 35.1 |
| 10 | r | 81.3 | 16.0 | 96.1 | 26.7 |
| 11 | r | 50.1 | 18.1 | 39.9 | 7.3 |
| 12 | u | 108.3 | 18.2 | 143.2 | 41.7 |
| 13 | u | 79.3 | 22.0 | 212.7 | 63.6 |
| 14 | r | 48.7 | 24.0 | 168.4 | 48.2 |
| 15 | r | 95.4 | 27.0 | 139.9 | 37.7 |
| 16 | u | 106.0 | 30.3 | 204.6 | 58.1 |
| 17 | r | 129.9 | 44.7 | 170.0 | 44.5 |
| 18 | u | 38.7 | 102.3 | 17.3 | 2.3 |
| 19 | u* | 172.9 | 113.4 | 385.2 | 90.6 |

*Taking ascorbic acid

than the other published college studies while the other Texas group falls between the 2.1 for Washington students and 50.7 percent for the Massachusetts group. One may conclude then that the nutritional status of Texas college women is similar to that of other college women in the United States on the basis of the resting level of ascorbic acid.

When the ascorbic acid saturation is based upon the 30% return of the test dose the picture is somewhat different since there were more who did not return 30% of the test dose than there were who had less than 15 mgs. resting level. The only study available for detailed comparison with the present one is that of the University of Texas. Table 4 compares the results of the two college groups to the test dose. Again the North Texas State Teachers College group shows fewer women in the unsaturated group, 26 or 52 percent as compared to 29 or 74.3 percent. Previous investigators have reported a very close correlation between the resting level of the test dose and have for that reason assumed that saturation at the resting level was sufficient to determine the ascorbic acid status of an individual. In this study such an assumption is not indicated because more of the subjects were saturated, 34 percent, at the resting level than at after the test dose, 52 percent.

The data obtained from these subjects included the amount and kind of exercise, perspiration, illness, and the drugs taken during

### TABLE IV

**The Number and Per Cent of College Women in The North Texas State Teachers College and The University of Texas Who Had the Various Percentages of Return of a Test-Dose of Ascorbic Acid**

| Return in Per Cent | North Texas State Teachers College Students | | Texas University Students | |
|---|---|---|---|---|
| | No. | Per Cent | No. | Per Cent |
| Below 15...... | 20 | 40 | 19 | 48.7 |
| 15–30......... | 6 | 12 | 10 | 25.6 |
| 30–50......... | 12 | 24 | 7 | 17.9 |
| 50–60......... | 6 | 12 | 1 | 2.6 |
| 60–100........ | 6 | 12 | 2 | 5.2 |
| Above 100..... | 0 | 0 | 0 | 0 |
| Total...... | 50 | ............ | 39 | ............ |

the seven days of the study. Of the 26 subjects who were unsaturated after the test dose ten gave a saturated response at the resting level. Six of these ten were taking drugs, primarily hormones and aspirin while the remaining four indulged in excessive exercises during the test with increased perspiration. Belser and co-workers (1939) suggest that manual labor and perspiration may affect the excretion of ascorbic acid while Hawley and associates (1936) show a relation between illness and the use of drugs. It is conceivable that the small amount of drugs used may not in themselves affect the response to the test dose but that the physical state which necessitated their use could affect it. When these ten are eliminated from the comparison all of the subjects with a resting level showing ascorbic acid saturation also give a saturated response to the test dose. It may be concluded then that college women on self-selected diets with a resting level indicated ascorbic acid saturation generally give a saturated response to a test dose.

## SUMMARY

The purpose of this study was to determine the ascorbic acid excretion, before and after a test dose of ascorbic acid, of North Texas State Teachers College women in order to compare their saturation with other college women of the United States.

Fifty college women, 44 of whom were home economics majors, served as subjects during a four-month period of time (April through July, 1943).

Ascorbic acid of the urine was determined for the resting level and again following a test dose of 300 mg.

An excretion of less than 15 mgs. per day was considered to represent unsaturation at the resting level whereas a return of less than 30% following a test dose was considered to indicate unsaturation.

Using these criteria 34 percent of the women showed unsaturation at the resting level while 53 percent were unsaturated after the test dose. These values fall within the range of previously reported studies.

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# Preventable Fetal Death

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Fetal death is caused by a large number of conditions both intrinsic and extrinsic to the fetus. Those which are genetically determined can be altered or permanently controlled only by genetic manipulation. Those which are developmental accidents may be based not on gene deficiencies or lethal factors in the fetus but take their origin in abnormal maternal serum or in complicated protein interactions across the placenta. The latter depend on incompatibilities between mother and fetus. In such cases, if the fetus is developed enough to maintain itself, premature separation from the mother removes deleterious influences and normal development proceeds. The same argument applies to those cases in which the maternal circulation carries drugs or toxins or active agents of disease which pass across or infect the placenta or change its permeability. In most of these cases death is not operative as an agent of natural selection and any measure used to save the fetus is eugenic therapy. As Potter said in 1918, causes of death operating during late pregnancy will never operate again.

We have recently become aware of the Rh antigen which is a genetic factor not in any way lethal or defective except under one particular circumstance—the fetus must carry the factor in a mother that does not. Even with this combination present only one out of twenty fetuses is affected. In a primipara it is not affected unless the mother has been previously sensitized. Both Davidson and Hunt have written good summaries of Rh mechanisms. At John Sealy Hospital last December we had a case of erythroblastosis and hydrops in a primipara who had been given blood transfusions twice ten years earlier. We have also seen two children in a family of four, show signs of erythroblastosis at birth and progressively deteriorate. Cook, in 1944, related Rh to mental deficiency. Because Rh erythroblastosis is rare it is difficult to secure enough antibody for test purposes. Every obstetrician who finds such cases should report to the serologist at his nearest blood bank to collect serum of this valuable type. The testing of female infants for Rh antigens is important prior to any transfusion and, in the near future, women contemplating marriage will become interested in their own Rh status.

Another type of fetal death, somewhat similar to the Rh picture and less well understood, is represented in 3 cases in this hospital this year. In each of these there is a history of several normal children, all heavy at birth, and showing increasing unresponsiveness at successive births. Each terminated the series with an edematous, full term, overweight stillbirth. Death occurs shortly before the birth. There is no extensive blood destruction nor erythroblastosis. There is complete acute destruction of the liver and of the renal

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*This paper originally written for the State Medical Association of Texas, and appears in the *Texas State Journal of Medicine,* November 1945.

tubules (not glomeruli, Henle loops nor ducts). Placentas and cords are proportionately large but normal microscopically. We are very much interested in the suggestion of Miller, et al., that such conditions may represent a prelude to active diabetes mellitus. If so, it raises a pertinent question regarding the serology of the prediabetic state because there is no glycosuria when the damage occurs. Even if there were it would not explain the profound effects produced across the placental barrier. Here is a field wide open to investigation.

Evidence is also accumulating concerning the etiology of stillbirth accompanied by developmental defects which of themselves seem not important enough to be a cause of death. Only recently experiments on nutrition and the classification of nutritional status in women at the beginning of pregnancy have been correlated with defective and normal fetal development. Allen, Macafee and Biggert in England, and Burke, Kirkwood and Stuart in the United States have shown excellent correlation. It is evident now that nutritional status should be made a record of the first importance on obstetric charts. Pregestational nutrition is just as important as that of late pregnancy. The specific neural effects of lack of vitamin A and skeletal effects of riboflavin are important studies by Hale and by Warkany. The whole picture of nutrition now ties up with effects of hypothyroidism and low basal metabolism which have been known for a long time. It was well stated by Litzenberg in 1939. Thyroid therapy to keep up basal metabolism which has been depressed by gestation and vitamin E or pituitary extracts have been clearly indicated to keep a hypersensitive uterus from reacting prematurely. These were analyzed by Falls in 1940.

Our interest in this problem includes studies on parathyroid and thyroid as well as an attempt to link superficial developmental defects to some deeper mechanism.[19] We have shown that serum calcium deficiency because of diet or hypoparathyroidism causes hypertrophy of fetal parathyroids in a quantitatively related equilibrium. It is known that the defects appear in tissue whose primordia at some time or other have very rapid rates of growth, either splitting into secondary axial extensions or uniting into common structures. Thus the lips, palate and nose often form a group together with failure of the vertebral arch to be completed. The fingers and toes web or duplicate and the complex alterations of the urogenital structures makes urology very much a study of anomalies. These are often associated with vascular deviations or abbreviations which are found only by very close study. Because they are omitted from published studies does not imply that everything not described was normal. In very early embryos the primary defect is often in the hemapoietic system and is seen secondarily in avascularity of the villi. This is fatal. Murphy and many others have concluded that these things are gene determined and our studies support the findings that they are familial. However, geneticists have found marked variability in localization and degree of expression of the abnormalities which again points to some underlying mechanism subject to external influences. Individuals are known to differ in their requirements for specific nutritive factors and for oxygen. If the reserve of these elements at the placental boundary is not sufficient they suffer.

Our intensive microscopic study of the placenta shows that placentas at term are not uniform in their state of differentiation. The younger they are structurally the more selective and less efficient they are.[20] This fact alone could determine, at critical moments, the withholding of essential things which the fetus cannot synthesize for itself. Any maternal factor altering that permeability is important. Before we can be sure that our problem is primarily genetic we must rule out inferiority of nutrition. Ratner's suggestion that the passive transfer of proteins across the placenta is a mechanism by which the problem of the inheritance of acquired characteristics might be approached should not be taken too seriously, though no suggestion should be discarded because of its unfamiliarity.

A few specific viruses have been traced across the placenta late in gestation.[13] We need much more knowledge as to the particular conditions under which this is possible in order to be on our guard. Organisms that will not pass may be disregarded; those which enter only at the end of pregnancy may be circumvented. It is valuable to know the potential dangers to which an infant is subjected as soon as possible.

Several months ago we started taking cord blood smears as a routine to see if we could correlate the blood picture with the neonatal history or other events. The smears were far from perfect and often the staff was too busy to make them when the most interesting cases appeared. After establishing normals, one smear appeared with a very high leukocytosis, mostly polymorphonuclears. Investigation showed the infant not acutely ill but lethargic. The mother and the baby were both studied and both showed some acute systemic infection. It cleared up in three days before we could determine its exact nature but the cord blood smear definitely demonstrated its presence at birth. Most premature stillbirths were lacking polymorphonuclear cells. Other interesting correlations were found in these differential studies, and it is suggested that cord blood smears furnish a base level for later comparisons that is of considerable value in ruling out or establishing the neonatal factors responsible for infant morbidity. No pediatrician wants to take responsibility for infections picked up in the nursery, and a cord blood smear may clear him.

Early aborted embryos are generally grossly malformed. Of fifty embryos in our collection below 28 mm. length, cut into serial sections, not one is normal except six removed surgically in sterilization operations or accidentally found in uteri where pregnancy was not suspected. This cannot be said of those aborted late in gestation. Here presumptive development has long been determined and only peripheral or non-fatal defects will appear. Gross cardiac anomalies are generally not critical until after birth. Serological fetal abnormalities directly related to composition of maternal serum are common and these, we hope, can be predicted in time to save the fetus by intervention. We must not remain fatalists about fetal death but learn that premature separation of the placenta and other unfavorable uterine conditions are preventable. Until we learn to control them we are in no position to say that fetal death claims the unfit. The fetus and its mother are independent genetic entities with a certain amount of common physiology. There is much hope for the near future.

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# Induced Variation of the Sex Ratio in Drosophila

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## INTRODUCTION AND LITERATURE

Experimental modification of the sex ratio in man and other animals has been the subject of conjecture and experimentation for many years. Over 200 years ago, Drelincourt listed 262 theories of methods to pre-determine the sex of unconceived as well as conceived but unborn children, all of which have failed to stand the test of time. It is rather obvious that any method of producing one sex or the other will succeed about 50% of the time, so advocates of any theory will have cases in point for substantiation.

Quite a furore of renewed interest was created when Unterberger reported success with his lactic acid, bicarbonate of soda technique at the international congress of genetics in 1930. However, since he worked with people and people are notably poor subjects for experimentation, other investigators tried his methods on other mammals to test his results. The Applied Research Laboratories at Dayton, New Jersey, tried the technique in 1938 on rats, with what might be called a blow by blow description of the progress of the experiments being carried by the *New York Times*. The results seemed convincing, with 167 out of 175 litters showing a predominance of males or females according to the treatment of the mothers before mating with acid or soda. Two employees of the newspaper became so enthusiastic that they began a private experiment of their own, only to disappoint their thousands of readers when a girl arrived instead of the expected boy.

Warren added weight to the theory in 1940 when he reported positive results with rats and rabbits, followed in the same year by a positive report from Roberts at the Univ. of Illinois. However, the pendulum began swinging the other direction when McPhee and Eaton called attention to the fact that insemination in the rat and other rodents might take place directly into the uterus without there being any chance of an effect by the walls of the vagina that had received the pre-treatment. Their results with the douches as well as the treatment of the sperm followed by artificial insemination in rabbits and guinea pigs were entirely negative. Negative results followed in quick succession from Quisenberry and Chandiramani at Texas A. & M., Cole, Casida and Murphree at the

Univ. of Wisconsin and others, until most investigators concluded that the chemicals used could not cause a differential death rate among the two types of sperm and, consequently, could not alter the sex ratio.

Investigation of the literature failed to reveal any similar attempts in the insects although Gowen and Nelson reported an inherited, sex-limited character in Drosophila that gave 100% males from females homozygous for it, while Gershenson, in Moscow, found an inherited character that gave 96% females in Drosophila. Cytological studies showed abnormal meiosis to be responsible for this condition.

The results reported in this paper arose from observations made during studies of the effects of altering the pH value of the food upon which Drosophila are raised.

## TECHNIQUE

Preliminary experiments were carried out with various concentrations of hydrochloric acid added to the usual banana, karo, agar food mixture, upon which Drosophila are raised. It was found that the flies would tolerate up to a 10% concentration of normal HCl. This concentration was used throughout the rest of the experiments since it would produce the maximum physiological effect without greatly reducing the viability.

Equal numbers of experimental and control vials of food were prepared and about ten pairs of wild type Drosophila melanogaster placed in each vial. After five days the parents were emptied from the vials. Counts of the two sexes were made from the offspring on the first day of emergence and every day thereafter for a period of nine days. Finally, some of the first generation flies that had spent their entire existence on the acid food were transferred to vials of plain food and the offspring from this cross tabulated and compared with that of the controls where the parents as well as the offspring had been raised on plain food. The experiments were repeated four times as a check on their accuracy, with similar results in every case.

## RESULTS AND DISCUSSION

Table 1 shows the percentage of males found among the flies emerging from the vials of the three groups, while Fig. 1 gives a graphic portrayal of the results. There seems to be no doubt but that the flies raised on acid food show a significantly higher percentage of males than the controls raised on plain food. While the first two days showed counts that were below 50% males, they are still noticeably higher than those found among the controls. All Drosophila workers are familiar with the fact that there normally tends to be an excess of females among the flies first emerging. The usual explanation is, that the female pupae tend to hatch out a little sooner than the male pupae. As the counts continued, however, the controls became established around 50%, while the acid food yielded around 60% males, or about one and one-half times as many males as females.

In seeking an explanation of these results, one of the first possibilities that might suggest itself would be a differential effect of the acid on the larvae. Perhaps the acid is unfavorable to the female larvae, causing a greater death rate among these and a correspondingly higher percentage of male adults. Another possibility would be a differential effect on the two kinds of sperm in the male parents, so that many of the X bearing sperm were rendered inactive and a greater proportion of the Y bearing sperm remained to fertilize the eggs and yield a higher percentage of males. Finally there might be some effect on the fertilized but unlaid eggs in the females. To test the relative merits of these hypotheses, the second series of experiments was conducted in which the flies that had been raised on the acid food were mated and placed on plain food. If the effect was on the larvae, the offspring of such a cross should not differ materially from the controls. On the other hand, if the effect was gametic or zygotic, there should be an increased number of males in this group.

The extremely high percentage of males (61%) among those first emerging from this cross as compared to the low percentage (36%) among those first emerging from the controls seems to indicate that the effect of the acid, whatever it may be, is on the parents rather than the developing larvae of the offspring. This probability is further borne out by the fact that the percentage of males gradually increases in the counts of flies raised on acid food, with the greatest number of males found among the flies which had descended from parents that had been on the acid the longest.

Further speculation must await the results of experiments now in progress.

TABLE 1

Percentage of Drosophila males hatching from vials of food containing 10% normal HCl, on plain food from parents raised on acid food, and on plain food from parents raised on plain food as controls.

| Day of Emergency | Raised on food containing 10% normal HCl | Raised on plain food from parents raised on acid food | Parents and offspring raised on plain food (Controls) |
|---|---|---|---|
| 1.......... | 47 | 61 | 36 |
| 2.......... | 46 | 56 | 40 |
| 3.......... | 55 | 55 | 47 |
| 4.......... | 58 | 51 | 53 |
| 5.......... | 58 | 48 | 47 |
| 6.......... | 60 | 50 | 49 |
| 7.......... | 59 | 51 | 47 |
| 8.......... | 62 | 48 | 51 |
| 9.......... | 64 | 52 | 53 |

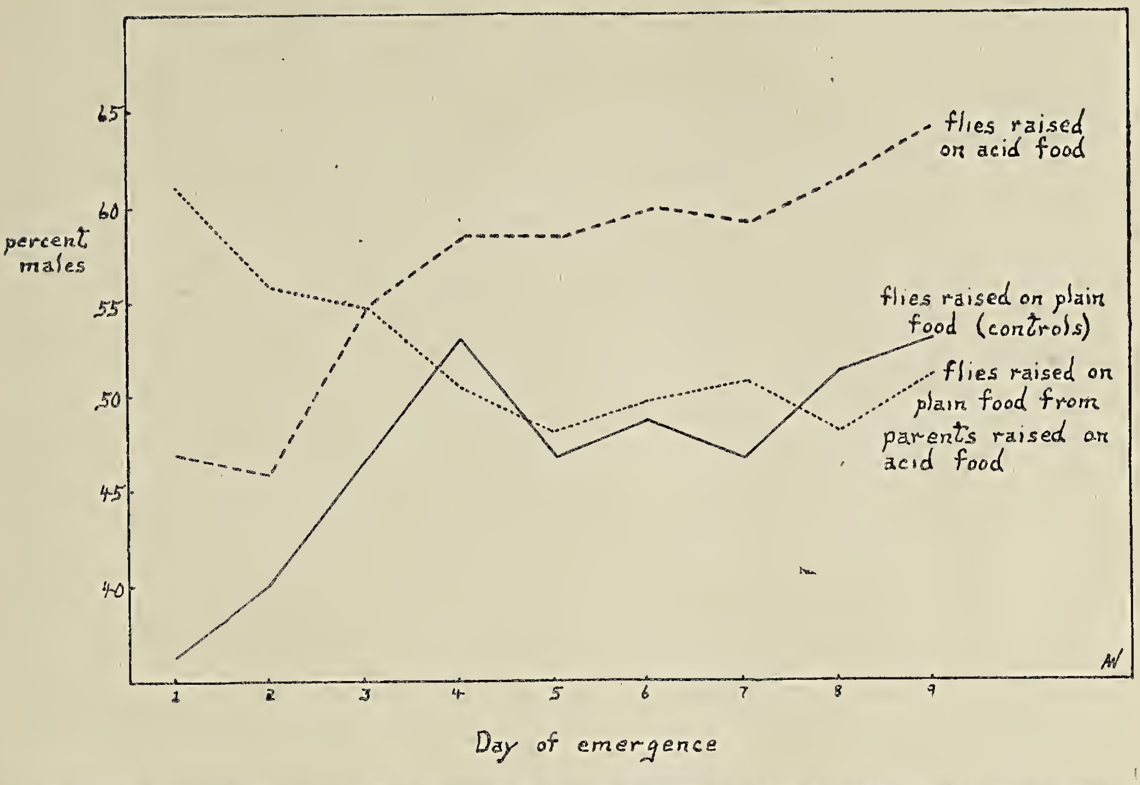

**Fig. 1.** Percentage of males hatching from different types of food. (To accompany, "Induced variation of the sex ratio in Drosophila," by A. M. Winchester.)

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## Characteristic Endemic Typhus With Ctenocephalides Felis Collected From Didelphis Virginiana

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The role of rats and their fleas in the maintenance of typhus fever in the southern United States is well established.[1,2] In fact, typhus is often called "rat fever" or murine typhus. While infection in man is generally believed to result ordinarily from deposition of flea excrement heavily laden with typhus organisms at the site of the bite, the victim is rarely able to recite anything of such a history. This is partly because a flea bite is usually a matter of little concern, and the victim may remain totally unaware of the bite. *Xenopsylla cheopis*, the tropical rat flea, is thought to be the principal and most important flea in typhus transmission. This is largely because of the relative ease with which this flea, as a rule, coincides far better than that of any other rat flea or other ectoparasites with the prevalence of typhus.

We[3] have reported on a small outbreak of typhus at Austin in November, 1942, which was intimately associated with kittens carried from a feed store. The fleas on these kittens were very numerous and of the 150 or more identified and tested for typhus, all were *Ctenocephalides felis*, the common cat or dog flea in this area. The present report concerns proof of the infectivity of the common cat or dog flea found on opossums near Shriner, Texas, in mid-summer of 1945. This observation was made during a rather thoroughgoing investigation of the epidemiology and possible control measures applicable to typhus as carried out in Lavaca County in south Texas by the State Health Department in cooperation with the U.S.P.H.S., other government agencies and groups, and the Game Management Department at Texas A. and M. College.

It was of considerable interest that these fleas were found in large numbers on the two young opossums trapped in an oil mill where the rat flea index was low presumably because of recent dusting of rat runs with D.D.T. The two opossums were found in steel traps set for rats June 14 and 15, 1945. One hundred and fifty-four *Ctenocephalides felis* picked from these opossums were stored under glass seal on dry ice. June 20, this pool of fleas was crushed in physiological saline solution and portions of the suspensions were inoculated into two white mice both of which subsequently developed good serum titers in the complement fixation test for typhus fever. The brain of one of these mice was crushed and inoculated into a guinea pig which, ten days later, developed a bilateral scrotal swelling characteristic of typhus fever. The infection has been maintained in guinea pig passage by inoculation of the tunica vaginalis tissue harboring typhus rickettsiae.

Since blood samples from the two opossums reacted negatively in the complement fixation test for typhus fever, the source of infection for the fleas remained undetermined. Although *Ctenocephalides felis*, the common cat or dog flea, is seldom found on rats in our experience, nevertheless, the fleas in this pool perhaps had picked up the typhus rickettsiae from infected rats which were known to be in the oil mill. *Ctenocephalides felis*, according to Matheson,[4] has a wide range of hosts and readily bites man.

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## The Treatment of Virus Diseases

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A rational approach to research on the treatment of virus infections presents numerous difficulties because of the nature of the virus itself. These agents multiply intracellularly and little is known regarding the mechanicism of their pathogenesis. Furthermore, since viruses lack independent enzyme systems, their metabolism must be intimately associated with that of the host cell. Their only attribute of life appears to be their ability to reproduce, and even here the energy of the host cell is necessary. It is not, therefore, surprising that they have proved refractory to the antibiotic, sulfonamide and other chemotherapeutic agents which have been so effective in combating other agents of disease. On the basis of our present knowledge regarding these simpler forms of life, the most promising method of attack with drugs would be that directed toward the reproductive process. It is probable that the virus, after gaining access to susceptible tissues of the host, stimulates the cell in such a way that it is diverted from its normal function to that of synthesizing the virus complex. Since these synthetic processes are presumed to be catalyzed by enzymes, virus reproduction may be inhibited by the phenomenon of drug-enzyme-substrate competition.

Sulfonamide therapy has proven successful in trachoma (Gradle, 1942), inclusion blenorrhea (Thygeson, 1941) and lymphogranuloma venereum (McKee et al., 1939); though there is increasing evidence that the causative agent of these diseases do not fall within the category of true viruses. Scattered reports of successful treatment of other virus diseases have appeared (Climenko, Crossley and Northey, 1939; Rosenthal, Wooley and Bauer, 1937), but the observations reported by these investigators still require confirmation. Apparently, good results with certain therapeutic agents may be due either to mistaken diagnosis or to the beneficial effects of concomitant therapy. These criticisms apply to certain studies indicating a favorable effect of the sulfonamides in the treatment of trachoma. Favorable experimental results with sulfonamides in the treatment of lymphocytic choriomeningitis have not been consistent; when effective they were dependent upon early administration and more nearly approached prophylaxis than treatment. Sulfonamide therapy has been given extensive trial in patients with primary atypical pneumonia. Neither symptomatic improvement or alteration in the febrile course was observed with any degree of consistency; many patients were even more uncomfortable when receiving the drugs.

Sufficient evidence exists to conclude that the sulfonamide drugs have no direct effect on infections caused by viruses. Secondary infection of the vesicles in smallpox is believed to be responsible for much of the late toxemia in this disease. It has recently been shown (Leishman, 1944) that the administration of sulfonamides throughout the course of the infection has strikingly diminished the degree of secondary infection and consequently lessens mortality. Penicillin has been observed to have a similar effect (Jeans, Jeffrey and Gunders, 1944).

Extensive attempts at serotherapy have likewise been unsuccessful in treatment of virus diseases. The primary difficulty with serotherapy lies in the fact that viruses are intracellularly situated and the immune bodies cannot reach the infectious agent because they are unable to enter the cell. Evidence also indicates that in most virus diseases, by the time symptoms appear, all cells which are subject to infection have already been invaded by virus. Future success in the treatment of virus diseases with immune bodies will depend to a great extent upon the development of methods for earlier diagnosis. For each intra-cellular parasite the appropriate time beyond which parenteral injection of antibodies is no longer effective must be determined experimentally. Despite several reports to the contrary, the treatment of virus diseases is of no value after the infection has become established. Convalescent serum, on the other hand, has been employed with success in prophylaxis and in modifying the course of certain diseases including measles, mumps and chicken pox. The antibiotics have thus far been found to be almost wholly without beneficial effects in the treatment of virus diseases (Krueger, 1943; Sulkin and Goth, 1945; Parker and Diefendorf, 1945). Heilman and Herrell (1944) found penicillin to be effective in the treatment of ornithosis; but Kramer and his associates (1944) suggested that the action of penicillin was not curative even though the mice remained well for appreciable intervals of time, since the virus could be recovered from the brain and other tissues of such animals.

In view of the apparent ineffectiveness of the various antibiotics, antiserums, and sulfonamides in the treatment of virus diseases, another approach to the problem is indicated. Any therapeutic agent which will be successful in the treatment of a neurotropic virus disease presumably must interfere with that phase of metabolism of the host cell upon which the virus depends, and must have predilection for cells of the central nervous system. The writer and his associates (Sulkin, Goth and Zarafonetis, 1946) have recently suggested that general anesthetics would fall within this category. Preliminary observations have indicated that ether anesthesia is effective in the treatment of Western equine encephalomyelitis in mice. Combined ether anesthesia and hyperimmune serum in the treatment of this experimental virus infection was even more effective (Sulkin, Zarafonetis and Goth, 1945). Certainly more extensive study in the experimental animal is necessary before this approach to the treatment of virus diseases can be properly evaluated. In the light of our knowledge today, treatment of virus diseases in general is largely a matter for future development.

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# Experiments With the Fruit of Cebatha Carolina (Moonseed Vine. Family—Menispermaceae)

(MRS.) NAWONA TAYLOR GARY
Experiments performed by Nawona Taylor Gary and
Roland Thacher Gary

## DESCRIPTION

"A vine with clusters of small red berries. It is very abundant throughout Texas in woods and on fences, ranging north to Kansas and Virginia. It is also called Coral bead, margil, coral vine, and red-berried moonseed. 'Cebatha' from the Greeks, alludes to its climbing habit, white 'moonseed' refers to the curved seed of the fleshy red berries which ripen in the fall and remain on the vines long after the leaves have fallen. The small white flowers bloom during the summer and fall. The leaves are quite variable, sometimes entire and sometimes distinctly 3-lobed, and are rarely 5-lobed, being smooth above and downy beneath.

"The berries of the Indian moonseed contain an acrid poison which is used by the Chinese in catching fish, as it will temporarily stun or intoxicate the fish." (From *Texas Wildflowers* by Eula Whitehouse)

## INTRODUCTION

Having just returned from a field trip, I was holding a cluster of waxy red berries in my hand as I read the description in an attempt to classify it.

"The berries of the Indian moonseed contain an acrid poison which is used by the Chinese in catching fish, as it will temporarily stun or intoxicate the fish," I read aloud slowly a second time with an idea dawning. I looked over at Gary and realized that the same idea had dawned on him. For weeks I had tried to "still" paramecia without harmful effects with little degree of success. The substances used seemed to always cause some reaction from the normal. If the Indian moonseed contained an acrid poison, we thought perhaps the *Cebatha Carolina* fruit would contain a substance to slow or quieten paramecia. Thus began the experiment.

Experiments:

The first experiments were merely feeble attempts to see if there might be something to the idea.

1. In a Syracuse watch glass containing several drops of paramecia culture, we added two crushed moonseed berries including pulp, skin, and seed. In a short time (five or ten minutes) they were slowing up percepitably. We were jubilant since there were no blebs forming. At twenty minutes they were quiet, but when the watch glass was moved, they stirred about lazily for a moment and then settled down again. After an hour they recovered and seemed to be apparently perfectly normal. This was repeated several times with similar results.

2. We boiled 25 berries (seed, pulp, and skin) in 10 cc. of tap water for thirty minutes, then drained off the resultant. This had no apparent reaction even when added in very large amounts up to ten parts of moonseed extract to one part of culture.

3. We took the pulp of 25 berries, placed them in a filter and poured 30 cc. of warm tap water over them. We did likewise with the crushed seed. When the extract had cooled we added it to the cultures. Neither gave any reactions. We mixed the extracts and added to a culture—still no reaction. We decided that the "acrid poison" was nonfilterable.

4. Gary then took 25 berries in 5 cc. of water and extracted the "poison" by water bath maintaining a temperature of 60° C. for 30 minutes. His experiment showed that it killed bacteria in the culture instantly, and killed the paramecia in about five minutes. They did not form blebs, but ejected trichocyst threads.

5. Gary took some berries that had been allowed to dry, crushed the seed and pulp, and added enough water to form a solution thin enough to be drawn into a pipette. Four drops of this solution was added to eight drops of culture. It stilled the culture in ten minutes. After fifteen minutes they were intoxicated, but still alive—the life processes were continuing. After twenty minutes they were still alive and more active. At twenty-five they were inactive and perfectly still. Tap water was added. Blebs formed and they soon disintegrated.

6. A trace of Salicylic Acid ($H_2Si\,O_3$) was added to preserve the above solution from fermentation. Nine months later the solution was still potent and was used successfully in laboratory classes.

7. Gary took skins of ten berries, added 5 cc. of water and placed in a 60° C. water bath for 30 minutes. Did not work. Intoxicating element was not in the pigmented epidermis.

8. We took only the seed of 25 berries, added 10 cc. of water and placed in a water bath at 60° C. for 30 minutes. No results. The intoxicating element was not in the seed.

Exhibit and Illustrations:

1. Fresh berries and leaves
2. Dried berries
3. Stippled drawings of
   a. Paramecia congregating in drop of "acrid poison."
   b. Ejection of trichocysta because of "acrid poison."
   c. Paramecium as drawn while under the influence of it.

## CONCLUSION

These experiments will have no momentous effect on civilization, but for those of you who work long hours with protozoa, you will find that this "acrid poison" will solve some of your problems, especially if your desire is to illustrate, draw, or photograph microscopic animals while they continue their life processes. It is quite a simple matter to collect the bright red seed of the *Cebatha Carolina* and allow them to dry. When dried, crush them, add tap water, allow to stand a short time, and then draw off resultant liquid in a small pipette. Add this to the protozoan culture that is being studied. If the solution is desired for a longer period of time, add a trace of Salicylic Acid ($H_2 Si O_3$) to prevent fermentation.

# The Use of ANTU As a Rodenticide[1, 2]

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The chemical compound ANTU, alphanaphthathiourea, has been pretty thoroughly tested out as a rodenticide in the laboratory and in field tests. It was first tried on a small scale with Norway rats with quite wonderful results, as from three to eight milligrams per kilogram of weight was sufficient to cause death of these rats. A great many field experiments were carried on by the Texas State Board of Health, but very poor results followed. The investigation of other workers indicated that from twenty to fifty times as much ANTU is necessary to cause the death of the Alexandrinus rats. In Texas, the Norway rats are found in abundance along the Gulf Coast, but in much smaller numbers in the larger part of Texas. The Alexandrinus rats are by far the most numerous in the central part of the State. This difference in the species tolerance is enough

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[1] The ANTU used in these investigations was furnished by the Office of Scientific Research and Development on recommendation by the OSRD Insect Control Committee.

[2] The Committee on Medical Research of the National Research Council authorized on October 19, 1945 the publication of this paper.

to account for the poor showing of ANTU as a rodenticide in these parts. Death of a few cats and at least one dog were reported, but this is most likely due to these animals catching and eating the rats after the rats were already poisoned. Some workers have shown that ANTU is from 20 to 80 times as fatal to caged Norway rats as the commonly used poisons. For the Alexandrinus rats ANTU is about equal to red squill in toxic effects. The killing of cats and other animals by eating poisoned rats is probably no greater a drawback than it is with other poisons. No cases of poisoning of chickens or other domestic animals have been reported.

ANTU was first used as a bait poison and also by direct stomach tube injection. The latter method gave the exact quantity necessary to kill rats, or the minimum lethal dose. The same direct method has, of course, been used with other poisons. In the experiments by the writer for the Texas State Health Department, ANTU was used as a contact poison in the typhus control program. ANTU and DDT were mixed and dusted in the runs and burrows. Rats lick the dust from their feet and swallow it, and are thus poisoned without the use of bait. This procedure was used here in all the work with ANTU.

The lethal effect of ANTU on man is rather a problem. Some workers have reported that it is probably non-toxic to man in any reasonable amounts. When mixing ANTU or using it as a dust, it is conservative to say that a gas mask should be used. However, in the work here reported, gas masks were not used at all. The finely divided dust is inhaled to some extent into the nasal cavity, where it is dissolved and runs down into the throat in small amounts, which makes a noticeably bitter taste. One or two workers have reported headaches after using ANTU in a dust form, but no indications other than these have been reported. It is quite probable that the continued use of ANTU as a dust might be a serious industrial hazard. Other workers have reported that ANTU is lethal to monkeys in about one-tenth of a gram per kilogram weight of the animal. This would be a light dose, and since monkeys are the nearest related to man biologically, the question is raised of why ANTU should not be highly toxic to humans also.

A great many objections to the use of ANTU can be found. No one knows exactly what the rats taste or smell, but it is quite likely that ANTU, when used as a dust would be inhaled by the rats, and that the taste and possible burning sense in the mucous membrane of the nose and throat would warn them of danger. A few days after the use of ANTU as a dust in the burrows and runs of rats, they seem to disappear: whether they have gone elsewhere to die, are sick, or have moved away, is somewhat difficult to state, unless the poisoning has been done in cages. Within a few days, however, the rats return or others come in their place. At least, this is true with the Alexandrinus rats. Rats may build up a partial immunity to ANTU, if they are able to return to their old habitats.

These are three pretty well sustained objections to the use of ANTU:

(1) It may act as a repellant.
(2) Rats may build up tolerance to the chemical.
(3) The chemical is effective for Norway rats, but nearly 50 times as much is required to kill the Alexandrinus rat.

Perhaps the greatest objection to the use of ANTU is that it is a slow poison. Where the rat infestation is light, very few dead rats have been found, and the time required is from three to seven or eight days after the dusting with ANTU. This shows that the poison is far too slow in its action to be of very practical value as a rodenticide.

Where the rats are very numerous, some have been found dead, but most of these were found from the sixth to the eighth day after the dusting of the poison in the runways. Some of the rats have probably died elsewhere and others have died in walls, under floors, or in other obscure places in buildings. It is these rats which die away from the places that have been poisoned that are responsible for deaths of a considerable number of cats and possibly dogs.

Field tests have been made in several counties of Texas with a mixture of ANTU 50% and the DDT 5% pure with the 45% inert powder. It was used as a contact poison only. The runs and burrows were pretty heavily dusted. This has been called the patch method by other workers. ANTU is an irritant to the feet of rats and some of it clings to the hair. The rats lick this off and swallow it and the result is the same as that of a stomach poison, probably the same as if it were eaten with bait. The ANTU has considerable lasting effect and if dusted in burrows may act as a poison or repellant, or both, for a considerable length of time.

As above stated, ANTU is not highly poisonous for chickens. As much as one-tenth of an ounce is required to kill a two-pound chicken. This fact alone should be considered in connection with the use of ANTU where chickens are fed. Keeping rats away from chicken feed is somewhat of a problem, therefore further experiments with ANTU as a rat poison is recommended where chickens are raised in large numbers. Further work with ANTU should be carried on with the rodents which burrow in the ground as it might be found to have a definite value for the ground type of animal. This would include the Norway rat, but would pretty generally exclude the Alexandrinus or attic rats.

The greatest objection to the use of ANTU is that it is such a slow poison. Experiments have indicated that it acts on some of the glands of the body. This may be the reason for its being such a slow poison. At least, many of the old poisons and some of the new are very much more rapid in effect, but further study of ANTU should be made before it is discarded as a rodenticide.

## ABSTRACTS

### The Use of Soil as a Stock Culture Medium for Filamentous Fungi

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This study was planned to develop a simple method of preserving molds in artificial culture. Repeated transfer on agar introduces problems for the laboratory of limited personnel and in some instances is detrimental to the culture, since preservation on agar and frequent transfer often produce changes in the fungus from the normal. An attempt, therefore, has been made to preserve a variety of filamentous mold cultures in sand and in soil at room and at refrigerator temperatures. A heavy spore (or fragment) suspension in saline of a culture grown on agar was added to tubes containing sterile sand or soil. Enough of the suspension was added to moisten the charge in the tubes. The inoculated tubes have been tested at intervals of thirty days for the past five months with favorable results as to morphology, physiological properties, viability, and the like, of the culture. Details of the method and problems encountered in the use of soil as stock culture medium are discussed in the paper. Refinements of the method are being sought, and further work to extend the method to include yeasts and fungus pathogens is in prospect.

### Absorption of Monochloroacetate from the Stomach and Intestine

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Monochloroacetic acid, a food stabilizer, was administered as a 0.05% solution to non-narcotized dogs by stomach tube and to dogs narcotized with pentobarbital by injection into the washed, ligated stomach and/or small intestine. The amount of monochloroacetate remaining after various time intervals was estimated by a modification of the method of Wilson. (1). In narcotized dogs given 50 ml/Kg. of monochloroacetic acid intragastrically, amounts recovered from the stomach after certain time intervals were: Immediate—95%, 5 min.—92%, ½ hr.—80.0%, 1 hr. 68.1%, 2 hrs.—46.3%, 3 hrs. —38.2%, 4 hrs.—28.4%, and 6 hrs.—19.7%. In a series of 11 dogs with about half the above dose (200-250 ml.), the average recovery in ½ hr. was 64% of that administered. The average recovery from the ligated small intestine of 6 dogs, after introduction of 200 ml., was 61.0% after ½ hr. Considerable individual variation occurred in these dogs, presumably largely due to more or less trauma incurred in the necessary manipulations.

In non-narcotized dogs given large doses by stomach tube, the per cent recovery was as follows: after 30 min., 23.3% from stomach, 4.4% from intestine; after 60 min., 9.9% from stomach, 0.4% from intestine. It is evident that monochloroacetate is quite readily absorbed or at least disappears from the gastrointestinal tract. It is apparently not hydrolyzed in the stomach, since practically 100% recovery was obtained from artificial gastric juice containing 0.05% monochloroacetate after incubation for 24 hrs. at 30° C., and an aqueous solution containing 50 mg./100 ml., yields no precipitate with an $AgNO_3 — HNO_3$ reagent after intervals of 1-3 weeks at room temperature (28°-32° C.). Some of the product may, however, unite with the proteins of the mucus on the stomach wall and thus reduce the recoverable amount. No evidence, however, of the precipitation could be seen grossly as would be expected with the relatively small amounts of the drug used in the present study.

## REFERENCE

(1) Wilson—J. Assn. of Official Agricultural Chemists, 25:145, 1942; 26:478, 1943.

## The Distribution of the Sand Fly (Phlebotomus) in the United States and Its Relation to the Transmission of Leishmaniasis

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The geographic distribution of five species of sand flies *(Phlebotomus)* in the United States has been enumerated and the potential danger of their acquiring and transmitting leishmaniasis to man and dog has been given special attention. It is important that epidemiologists, clinicians, and health officers be alert and prevent the contact of dogs and sand flies to exogenous cases of leishmaniasis in these regions.

## Soil Fertility and the Activities of Azotobacter

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Since the isolation of an aerobic nonsymbiotic nitrogen-fixing organism by Winogradsky, much interest has been shown in the study of the conditions which promote the occurrence, growth, and activities of Azotobacter. Efforts have been made to relate the activities of Azotobacter to the reaction of soils or other media, to the fertility of soils or nutrient levels of other media, to the presence in the media of non-nutrient or possibly to toxic substances. The beneficial effects of calcium, magnesium and phosphorus on the welfare of bacteria that are associated with nitrogen economy in soils have been demonstrated. In the case of azotobacter, however, the results of numerous studies reported in the literature do not always show a relation between the levels of mineral nutrients and the activities of the organism.

The study reported here was conducted for the purpose of securing additional information on the effect of calcium saturation of the soil on the growth and nitrogen fixing ability of azotobacter. The results obtained lead to the conclusion that adequate supplies of calcium are essential for the activities of this organism. That the factors influencing the growth and nitrogen-fixing power of Azotobacter are complex and interrelated are indicated by this and other studies.

## Innervation of the Pars Distalis of the Armadillo Hypophysis

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Considerable disagreement exists as to whether the fibers of the hypothalamico-hypophyseal fasciculus innervates the pars distalis of the pituitary gland. Morphological studies of the nerves in the anterior pituitary of most mammals have yielded few nerve fibers, at least with the silver techniques most commonly used; yet physiologically, there is much evidence in support of a functional secretory nerve supply to the anterior lobe. Such is evidenced particularly by non-spontaneous ovulators as the rabbit, which invariably ovulates approximately 10 hours after coitus. The rat also strongly indicates a genito-pituitary reflex in that the female may become pseudo-pregnant after glass rod stimulation of the vagina or sterile mating.

In this study the armadillo was chosen because. it possesses a relatively simple hypophysis without a pars intermedia. There is also a connective tissue septum between the neural and the buccal portions of gland which facilitates tracing the nerve fibers from the posterior lobe into the pars distalis.

The procedure of preparation consisted of rapid fixation of the gland immediately after the animal was sacrified. The tissue was run up and sectioned in the usual manner and stained with a modification of the protargol method.

Fibers were found to enter the gland from two sources; from the autonomic plexus accompanying the hypophyseal arteries and from the infundibular process. The majority of the fibers enter the anterior lobe adjacent to the posterior lobe. These fibers passed along the connective tissue trabeculi, assume an extremely tortuous course, interwinding among the cell cords. At various intervals very fine fibers arise from the main fibers, branch several times and give rise to fine network. Often the fine branches can be traced between and in contact with the glandular cells or to a tufted ending.

## Note on the Determination of Nucleic Acid and Its Derivatives

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Experiments have been carried out for some time to determine the concentration of ribo-nucleic acid and desoxyribo-nucleic acid in tissue and micro-organisms. For desoxyribo-nucleic acid the diphenylamine method of Diche was adapted as a micro technique. It was found that other compounds present in crude source material interfere with this colorimetric reaction. Therefore the separation of the desoxyribonucleic acid from the interfering substances will be necessary prior to the determination.

The determination of ribonucleic acid and ribo-nucleotides is less complicated. Our test is an adaptation of Bial's orcinol method. It is possible to determine amounts from 2 to 20 micrograms with reasonable accuracy. The intensity of the green dye formed in this test is proportional to the nucleic acid (ribose) present. Interfering tissue elements are eliminated by extracting the dye with amyl alcohol. In using similar techniques many investigators have overlooked the fact that the pentose reaction should not be ascribed solely to the tetra-nucleotide. The concentration of other ribose-containing nucleotides, particularly adenine nucleotides and nicotinamide nucleotides, is so high in some tissues that they may account for as much as 25% of the total pentose determined.

## Studies on the Light Preference of Some Grassland Invertebrates. Preliminary Report

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Three animals characteristic of summer grasslands have been studied: *Lygus pratensis*, *Dictyna longispina*, and *D. volucripes*. Immature *Dictyna* spp. have also been tested. Each animal, placed in the stem of a Y-tube, was allowed to choose between darkness and light of a moderate intensity from a fluorescent lamp. Tests were made at temperatures of 26°-35° C., and at different times of day. Results indicate that temperature has very little influence upon the preference of any of the animals studied, all of them showing a strong attraction to light. For *L. pratensis* the time of day has no effect upon light choice; but all the *Dictynas* suggest a diurnal rhythm, selecting darkness more at twilight than during the day, and still more at night.

## An Analysis of Chromatin Bridge Formation in Setcreasea Brevifolia (Torr.) K. Sch. and Sydow.

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In *S. brevifolia* chromatin bridges associated with acentric fragments are seen during anaphase I. These are considered to be the result of a single crossover in the inverted segment in a pair of chromosomes heterozygous for an inversion which does not include the centromere. Other nuclear irregularities are also present during meiosis.

## The Influence of a Cocoa Beverage on the Metabolism of Six Pre-School Children

REUBY TOM RHODES

Under supervision of Mina W. Lamb, Texas Tech College (Master's Thesis 1944) on file in Texas Tech College Library completed

Since considerable controversy exists as to the advisability of including cocoa or chocolate beverages in children's diet, this work was undertaken to determine the influence of a cocoa beverage on the metabolism of pre-school children.

Three boys and three girls, 3½ to 4 years of age, were used as subjects since they had been previously conditioned to the procedure. Determinations were done on four mornings as nearly consecutive as possible. The basal metabolism determinations were made on the first and fourth mornings. On the second and third mornings the control beverage (omitting cocoa) and the cocoa beverage respectively were given prior to the metabolism determination. Two sets of determinations four weeks apart were made on each child.

The average basal metabolism of the subjects was 885 Cal./24 hrs., 47.7 Cal./kg./24 hrs., and 1149 Cal./sq.m./24 hrs. The actual metabolism varied from +9 to —13% from the standards available for children. The greatest stimulation above basal metabolism of the cocoa beverage was 12% after 20 minutes which was 3% more than the stimulation of the control beverage.

## A Further Analysis of Food Selection of 80 Families in Lubbock, Texas

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The food selection in weekly dietaries of 80 white families of Lubbock, Texas selected at random in the spring and summer of 1942 and spring of 1943 were analyzed. No consideration was given to the quantity of food consumed or the number of times each item appeared in the weekly diet. These families and their dietaries were grouped as to quality of dietary, income level and occupation to determine the influence of these factors on the selection of food.

Families with dietaries of good quality have a wider and more adequate selection of foods than those whose food consumption was of poorer quality. The variety of foods selected decreased in proportion to the decrease in the quality of dietary. The greater the income up to $4000 the better the food selection. Above this level of income the variety of food selected decreased. The greater the occupational training the better the food selection

—with, for example, the labor group showing a more limited selection than the skilled trade group.

Such foods as eggs, granulated sugar, shortening, potatoes, meats (particularly beef and pork), and refined cereals were selected by all the groups uniformly. The greatest variations in the food selection of these families came in the selection of such protective foods as fruits, fresh and canned vegetables other than potatoes, whole grain cereals, butter, margarine and milk. These protective foods are the best sources of minerals, vitamins and aminoacids and therefore are needed for optimum nutrition and health.

## Basal Metabolism of Eight Nursery School Children Determined at Three-Month Intervals*

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The basal metabolism of 8 normal children, 2 years, 4 months to 3 years, 9 months of age was determined at three-month intervals by use of a Collins-Benedict-Roth recording respiration apparatus. The subjects had been conditioned to the procedure. The uniformity of the results verified the high degree of cooperation achieved by these subjects in following the standard procedure for the determination of basal metabolism as given by DuBois.

Each morning two 8-minute determinations were made and repeated on another morning until the lowest value for oxygen consumption obtained was within 5 per cent of another value. In all cases was the lowest value checked by at least two others. The basal metabolism of the subject was that value obtained by averaging the lowest value with all those within 5 per cent of it. From this average value all calculations were made.

The basal metabolism of these subjects varied the most when expressed as Calories per 24 hours and the least when expressed as Calories per square meter. With increase in age, the Calories per kilogram of each of six of the subjects decreased, whereas no consistent variation occurred in any of the other methods of expressing Calories. When the subjects were arranged into 6-month age intervals, the average total Calories per subjects increased with increase in age. No consistent changes occurred in any other method of expressing Calories.

The basal metabolism of these subjects deviated from the accepted standards for children of their age from +31.0 per cent to —20.1 per cent. All deviations from the values obtained from Dreyer formula were negative, whereas those from the standards of Benedict and Talbot were consistently positive. From these deviations one would have great difficulty in determining the normalcy of any one subject.

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*Accepted for publication by American Journal Diseases of Children.

## Poetic Propaganda for Biological Teaching

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### PHYSIOLOGUS

"Knowledge is power" though teachers oft with zest
  Pile fact on fact in willful disregard
  Of limited retention and discard
As propaganda any valuation test.

"Know thyself" and mind and body train
  For health and happiness are close akin
  And beauty lies much deeper than the skin
In thought and speech projected from thy brain.

Man sought the meaning of his throbbing heart
  For centuries before a Harvey knew
  The double path of blood through valve and tube
And capillary bed's essential part.

Both pulse and fever were the diagnostic aids
  Of ancients, yet the source of heat unknown,
  The role of marrow in the ends of bone
Or cells reacting to bacterial raids.

The savage knew the virtues of his food
  The medicine and poison, root and herb.
  This age needs more to scan the salesman's word
And subtle means by which our purse is wooed.

What wonders lie in endocrinal gland
  In nerve and muscle, kidney, lung or brain,
  In eye and ear which o'er perception reign
To dominate the thought and guide the hand?

In reproductive process lies a road
  To national survival or decline.
  The genes define the height which each may climb
And serve eugenics as a constant goad.

Ye seek in education discipline
  Of mind and body that foretells
    Successful lives with some approach to bliss.
Why look abroad when so much lies within?
  No greater marvel than the living cells
    No knowledge of more worth for youth than this.

Printed in Bios, Vol. 16, No. 4.

## SECTION III. THE SOCIAL SCIENCES

General Theme: Problems of the Rehabilitation of the Ex-Service Man.

### PAPERS

# Modern Treatment in Psychiatry

TITUS H. HARRIS, M.D.

In the past, the management of mental patients was based on the premise that mental illness was incurable and that it was constitutionally induced and inherited. Mental hospitals were arranged only to provide custodial care and to make the occupants as comfortable and as happy as possible with a minimal expense to the state. Little effort was made to treat the patient with the idea of eventually returning him to the community. As a consequence, state and private hospitals frequently had small and poorly trained staffs of physicians and nurses. These conditions prevailed until the first part of this century. At that time two great movements arose, both of them destined to become of great significance in psychiatry. Both stimulated research into causes and treatment, and their influence is still being felt in our present method of managing mental illness. Both of them emphasized the fact that mental illness was at least in part acquired and, therefore, could not only be treated but in some measure prevented. These two movements were the psychoanalytic school of thought and the mental hygiene movement. Psychiatry has continued to advance during the past forty years as a result of these and other stimulating forces. Psychiatric education has improved, resulting in a greater appreciation of the part played by psychiatry in illness in general. With such realization many more physicians have become interested in psychiatry as a specialty.

The period under discussion today, however, should embrace those improvements in treatment procedure which have developed during about the past ten years. It is during this period of time that we have seen almost a complete change in methods, especially as regards the management of the major mental disorders.

This subject can best be discussed under two headings—first, improvements in hospital arrangement and methods of management of patients, and, second, specific treatment measures.

As has been indicated, improvements made in our large state hospitals—better buildings—larger and better trained staffs—application of the modern methods of treatment—and, establishment of buildings for reception of acute cases have generally resulted in shorter hospitalization periods for patients with more recoveries. There has been a move, too, toward the establishment of small acute hospitals in connection with medical schools and medical centers. This has the advantage of placing the mental patient for treatment where there exist all of the modern methods of examination and treatment and enables the patient to have the advantage of consultation facilities with the other medical specialties. It places mental illness on the same plane as any other illness. In line with this concept, there is a trend toward the development of psychiatric units in general hospitals and many of the large general hospitals now have such units. It has been proved that such units can function successfully, both from the standpoint of the patient receiving good medical care and the hospital being able to furnish complete medical service. The advantages of such an arrangement can readily be seen. Since mental illness is placed on the same basis as any other illness, internes and nurses are able to receive training in psychiatric methods, and the curability of many mental illnesses can be demonstrated to the members of the hospital staff. With such a reciprocal arrangement, the entire staff of the hospital develops a wholesome attitude toward the mental patient. It is educational to the community and the public, and helps greatly in removing the still existing stigma surrounding mental disease. It is felt that every general hospital should have provisions to care for the very acute mental patient thus preventing his having to be sent hurriedly to a mental hospital. Such a procedure is particularly unfortunate and unnecessary when the illness is physical or toxic in origin and of short duration.

There have also been improvements made in the management of mentally ill patients who do not require hospitalization. Out patient examination and treatment is probably best suited to the minor types of disorder, that is, the psychoneuroses, but the major illnesses suitable for electric shock treatment can be many times successfully treated without admission to a hospital. Patients with very severe depression can be cared for by the family and brought to the hospital for treatment on specified days. Many times, the patient may come from quite a distance for treatment returning home the same day. Such a method of management minimizes the intensity of the illness to the patient and the family, and it helps relieve the already crowded conditions existing in most hospitals today. The patient and the family usually prefer this method to placing the patient in a hospital.

At this point, it is proper to discuss the present policy regarding methods of admission of patients to mental hospitals. There have been improvements in our commitment laws. The present 90-day temporary commitment law, existing in this state, is an excellent one, and provision is also made for the admission of the voluntary patient. There is a movement today for greater utilization of the voluntary method. Perhaps 80% of mental patients can be admitted under this plan, if the physician makes an effort to establish the necessary relationship with the patient and between the patient and his family.

The improvements in hospitalization and methods of admission of patients to hospitals are, however, probably less important than the advances which have been made in the special methods of treatment. Among these, the shock method of treatment stands out as the greatest advance. Insulin shock treatment was introduced into this country about ten years ago and was accepted with enthusiasm everywhere. It was used in what was regarded as the most severe and less curable types of mental illness. Many such cases were cured and many more were improved. The enthusiasm with which it was first received has abated considerably, but it is still of value and is being used in most hospitals which have sufficient staff to carry out this more or less complicated method. Briefly, it consists of giving the patient a dose of insulin sufficient to induce a coma in which the patient is allowed to remain for an hour. The coma is then interrupted by administering sugar solution either by tube or vein. The comas are induced six days a week until improvement is accomplished or until it is decided the procedure is of no value to that particular patient. There are some hazards but if the method is properly carried out the danger is minimal, and, certainly, is far outweighed by the possible value. The results in general are, roughly, recovery in 30% to 40% of properly selected cases in two to three months, with improvement in a similar number of the remainder to the extent that a social remission occurs. The latter are subject to relapses and recurrences. This type of treatment is especially useful in patients with an acute schizophrenic reaction. The insulin method not only has furnished a valuable instrument in treatment but its discovery has done more to stimulate psychiatry and psychiatrists than anything that has occurred during the past 100 years. Research growing out of the stimulus provided by the discovery of its efficacy led to another method of shock treatment, using metrazol. This consisted of giving measured amounts of the drug into the vein of a patient for the purpose of producing a convulsion. It had been found that those patients taking insulin who had convulsions during coma sometimes improve more quickly. The metrazol treatment was found to produce its effects more rapidly, and it has the advantages also of being less hazardous to the patient and simpler to use. However, it did not seem to be as effective in the schizophrenic reactions as insulin therapy. On the other hand, it was soon discovered that metrazol was almost uniformly effective in relieving the depressive types of mental illness, so that a special remedy was now available for each of the more severe and more common types of mental disease. Metrazol, however, was a very unpleasant type of treatment from the patient's standpoint, so that a search for a better method continued. The result of this search was electro-shock, which has the same curative value of metrazol without its unpleasant features. The hazard to the patient in either of these methods was not to life, since fatalities practically never occurred, but there did occur occasionally a fracture of a bone due to the vigorous muscle pull occurring during the convulsive phase of the treatment. The need of avoiding this complication led to the discovery of the value of curare, which caused sufficient relaxation of muscles during the treatment to prevent the occurrence of fracture. It is felt that the ideal procedure today is the use of curare with electro-shock. The combination of the two provides a method of treatment for depressive illnesses which is practically free from danger and not too unpleasant to the patient. It is effective in a high percentage of carefully selected cases, enabling patients who formerly would have remained sick for months or years including many who would not have recovered at all, to obtain complete relief within a month or six weeks. In many cases the need for hospital care was completely eliminated.

As can be noticed from the foregoing remarks, the trend in the management of mental patients today is in the direction of treatment. Every method available to control unpleasant symptoms and speed recovery is utilized. The use of hydrotherapy in the form of wet packs and continuous tubs is an important adjunct as is the use of sedation when indicated. At times, certain excited and depressed patients are resistant to the shock methods described above and continuous sleep or narcosis therapy is used. Patients are kept continuously asleep with sedative drugs for one or two weeks at a time, sometimes with excellent effect in ameliorating symptoms. Where physical support is necessary small doses of insulin are used for the tonic effect and to create a greater desire for food. Vitamins are liberally prescribed where their use would seem to be indicated.

In the toxic and infectious group of illnesses, the recently developed drugs are used. Penicillin and the sulfa group of drugs have been found to be as helpful in the infections causing delirious reactions as they are in other medical illnesses. Penicillin has been proved of value in early syphilis and it is almost certain that it will exert a favorable influence on syphilis of the nervous system. It is too early in the use of this preparation to state results with certainty, but thus far the results have been favorable. As yet Penicillin is used only in conjunction with fever therapy and chemical agents which have been proved to be of certain value.

A word should be said about the management of the senile patient. The standard treatment for this group of patients is physical support in every available form. Many old people who show evidence of organic brain disease do not have, in fact, senile degeneration but have organic changes due to reversible factors. It is now well known that elderly people absorb and utilize vitamins poorly, so that not infrequently organic symptoms are seen on the basis of a vitamin deficiency. This group of patients recover with properly administered vitamin therapy.

The foregoing has had to do largely with the management and treatment of the major mental disorders. There remains, however, another group of psychiatric conditions, which are perhaps more important, that demand consideration. This group is composed of the psychoneuroses. The treatment of the psychoneuroses requires an approach which is different from that described above in as much as they less often require hospitalization and they do not respond to shock treatment. The treatment of a psychoneurosis is based on an effort to bring about a better state of adjustment between the patient and the environment in which he is attempting to function. Such an effort first entails a detailed study of the patient as an individual personality together with all the situations and problems that confront him, in order that the patient's equipment and his needs and the unsatisfactory factors to which he is reacting may be thoroughly understood. With such an analysis, an effort is made to fortify the patient's capacity to adjust by correcting mistaken information and removing unhealthy attitudes so often based on an incorrect point of view. The correctable factors existing in his world are also removed, if possible. Such a method of treatment is called psychotherapy. Any type of treatment that influences the patient's attitude toward himself and his illness in a favorable direction may be called psychotherapy. It is one of the oldest methods of treatment known and is constantly being used by every physician. It is almost the sole agent of treatment in the psychoneuroses. Psychoanalysis has been the most profound method of psychotherapy and is indicated in the more severe and more chronic types of psychoneuroses, but it is not available except to a relative few because of the small number of psychoanalysts. The time consumed and the expense of the treatment are prohibitive in most instances. Hence, other methods have been devised and used successfully. The psychoanalysts themselves are now using briefer methods of treatment, which they call brief psychotherapy. In brief psychoanalytic therapy attention is still directed to unconscious material existing in the patient and which is largely the cause of his problems, but less time is consumed, and the analyst is available to a larger group. Other methods of psychotherapy deal more with conscious factors and direct attention to the situation confronting the patient. There is no question that many people can be relieved of a troublesome symptom, many times physical in its expression, in a single interview during which the point of view regarding an illness or a situation is corrected. This is brief psychotherapy indeed. Psychotherapy, then, is the instrument of treatment by which that large group of illnesses, the psychoneuroses, must be treated. While it is used primarily by psychiatrists, it must be used by every physician regardless of the basic nature of the condition he is treating.

Before closing a discussion of modern treatment methods in psychiatry, mention should be made of a surgical procedure which has been introduced during the past ten years. Freeman and Watts were the first in this country to utilize a method of cutting the nerve pathways leading from the frontal lobes of the brain to the deeper structures. This operation, called prefrontal lobotomy, or better, leukotomy, seems to inhibit a person's capacity for worry, without interfering with his intellectual function. Many chronically depressed patients and certain severe psychoneurotic patients are improved following this procedure. Other types also respond in varying degrees. Such a procedure is drastic and final and should be used only in those who have failed to show improvement despite all other methods.

In this discussion an attempt has been made to point out the fact that today, in the management of the mental patient, emphasis is placed on treatment in the same sense that is true in other fields of medicine. Psychiatry now occupies its place among the medical specialties. Because of the increasingly healthy attitude on the part of the medical educators, the practicing physicians and the public, the patient with a mental illness is given an opportunity to recover as in any other illness. With this present better understanding, psychiatry bids fair to continue its progress.

## Problems of the G. I. in Industry

C. W. PEAVEY, Senior Training Officer for Trade and Industrial Education, Veterans Administration

I have been requested to speak on the subject of "Problems of the G. I. Industry." I prefer to think of this in terms of the "Problems in Training the G. I. in Industry".

As some of you may know, I have had rather close contact with the veteran for quite some time. During the summer of 1944, I organized an educational program for veterans of World War II. We believe that was the first such program in the nation organized by a public school system wherein the enrollment was limited to veterans only. It was organized before the G. I. bill became effective. We knew such a bill was in the making and we were getting ready to do our share for the boys who came back. I carried on and developed that program for one year and one day before entering the employ of the Veterans Administration. First, I should like to tell you of my findings and experiences in carrying on that program, and second, I should like to tell you of the problems as I see them now and the challenge that I feel we, as educators and public-spirited citizens, must meet.

That program was organized in the San Antonio Vocational Schools, in cooperation with the Texas State Board for Vocational Education, first on the part-time cooperative plan pending the formal opening of school and then broadened to include some pre-employment training. It offered training in forty-six different occupations, most of which were in the industrial field. It soon became evident that we were confronted with, not only the problem of adjusting the veteran to industry but also, the problems of assisting the veteran in making his adjustment socially and economically. By this I mean that his needs were far greater than only the adjustment of his educational and industrial problems, that he came to us for counsel and guidance in practically all other problems. Economically he was not able to sustain himself while in training without receiving financial assistance in one form or another. In many cases his earnings for his work in on-the-job training was not sufficient to supply his needs. Practically all of them had used up their muster out pay and had no resources other than their earnings and their subsistence allowance from the Veterans Administration when that became available. Later, after the G. I. Bill became effective, in many cases the interval between enrollment and the receipt of subsistence allowance was from two to four months. This delay being caused by the need of getting the records of the veteran from the "four corners of the earth". I think we all recognize the fact that $50.00 per month for a single man and $75.00 for a married man and $92.00 and $103.00 respectively, for the disabled man, at this time, is not sufficient to live on and keep soul and body together while in training. Therefore, in order to enable the veteran to have some income other than his subsistence allowance and also to enable him to have some income pending an award of subsistence allowance, it was arranged to carry on this program on the part-time cooperative basis with some modifications, and if the veteran were enrolled in a subject that would not lend itself to the part-time cooperative plan, arrangements were made for the veteran to have part-time employment after school hours, the earnings from which would supplement such funds as he might have and such subsistence allowance as may be awarded to him.

We found that practically all of them had a different outlook on life from what they had before going into the armed forces, that the quite young veteran of from 21 to 23 years of age was not mentally 25 to 28 years of age. We found, as all of you know now, that he had become more serious-minded, and that he generally knew quite well what he wanted. We found that practically all of those enrolled had gotten completely out of the habit of study and that many, even though they had a strong desire for learning, found it rather difficult to get back into the "harness", so to speak. Also we found that many of them needed services other than educational services, such as a need for glasses, a need for dental and medical attention, assistance in the preparation of papers required by the Veterans Administration and the U. S. Army Department of Insurance, loans and what not.

In this program we had all kinds of veterans, those who had been in the armed forces no longer than ninety days and who were discharged by reason of the fact that the Army could find no place in the armed forces where they might "fit in"; others who had been in the service for a year or more and who were discharged by reason of an injury; others who had been in battle in the European and Pacific Theatres; some who had lost a leg and even both legs; others with silver plates in the skull and others with various other kinds of wounds or injuries. As would be expected, the educational attainments of these people were anywhere from no school at all to the first and second year of college. Practically 80% of them were interested in learning an industrial occupation, some of whom also wanted a high school diploma and a vocational certificate. A small percentage were interested in only high school graduation and the balance of them wanted training in such occupations as clerical and stenographic work, commercial art, photography and the like. Fortunately we were able to offer practically anything that was wanted, from elementary school subjects through junior college.

One very interesting phase of this program was that organized in elementary school subjects, the enrollment in this division ranging from those who had never attended school at all up to those who had completed the fifth and sixth grade of common school. This part of the program was organized on an adult level, being separated entirely from the regular day school, all teaching was done on an individualized basis. You may wonder when I speak of those who had not attended school at all, of which we had four enrolled, all of whom were fine red-blooded American boys ranging in age from 23 to 27, two from the state of Mississippi, one from Tennessee and one from Alabama. I recall very clearly one who could sign his name but who was not able to read at all and that on several occasions it became necessary for me to put him on the bus to make sure that he did not take the wrong bus. In this phase of the program, we provided the veteran with three hours of school shop work in the occupation of his choice and three hours of common reading, writing and arithmetic. A few who wanted to learn an occupation not offered in the school were placed for one-half day in on-the-job training. These included such occupations as Artificial Dentures, Lens Grinding, Typewriter Repair and Grocery Store Stock Clerk. The elementary school subjects provided for these people were all very simple along the lines of the work in which they were engaged, thereby using their interest in their occupation as a vehicle for the teaching of reading, writing and arithmetic. Articles for their reading were selected from trade magazines, pamphlets and the like, most of which had to be altered by the instructor so as to reduce it to the level where they were able to, not only learn the reading but also understand the meaning. The progress in this group at first was slow but later gained very rapidly. Those of the third and fourth grade level learned so rapidly that in many cases it kept the instructors busy working overtime in the preparation of instructional material for them. With reference to their problems on-the-job, we found that in a large percentage of the cases they were very quick to adapt themselves to their new surroundings and to their employment situation. There were, as would be expected, a few who by reason of the rapid execution of the processes of the work in which they were engaged became very nervous at the outset but by careful supervision and through a sympathetic understanding of their problem, we were able to assist them in adjusting themselves so that most of them soon overcame this difficulty. Salaries paid to these people were 40c to 50c per hour for approximately four hours each day or twenty-six hours per week, including Saturday. The problems of these people were no different from the problems of those enrolled in vocational terminal and high school courses. In many cases those who were enrolled in vocational terminal courses were given basic training in the occupation of their choice for four to six months before being placed in the cooperative training part of the program. The progress of those who received this basic training was definitely faster after entering the cooperative training program than was the progress of those who did not receive this basic training.

All of these people were constantly under the care and supervision of a Co-Ordinator, whose duty it was to make arrangements with industry for on-the-job training, if and when they took their training that way, and to set up a training agreement which would include the work experiences to be provided by the employer-trainer and a course of study in the technical subjects, for the job, to be provided by the school. It was also the duty of the Co-Ordinator to follow up these people on the job and to correlate instruction in the school with work experiences on the job thereby bringing together theory and practice to make for well-rounded training. As another part of this Co-Ordinator's duty, he was required to serve as counselor and advisor to the veteran and to assist the veteran in the adjustment of all of his problems that might interfere with or impede the progress of the veteran in the school and on-the-job. I have heard it said that a Co-Ordinator of this kind should be concerned only with the educational problems of the veteran. I agree that may be the case in a general vocational school program, however, in the case of the veteran I feel that we should extend our services and render a service in all matters that may interfere with progress in learning. By this I do not mean that we should duplicate the service offered by other agencies. I do mean that we should be well aware of all the services offered by other agencies and be prepared to refer the veteran to those agencies for assistance in adjusting such problems. For example, sickness in the home is an inhibiting factor when it disturbs the peace of mind of the man who is in training. We all know that in many cases the young man acquired a wife while in the service. He is now living away from his home and probably away from her home. He is not aware of the problems of married life and often needs the counsel and the services of others. The victim of shell shock, commonly called battle fatigue, and those who have suffered the shock of the loss of an arm or a leg are especially in need of the services of which I speak. I do not feel that we should coddle or "wet-nurse" these people, but I do feel that we should try to maintain a sympathetic understanding of their problems and assist them in every way possible. This calls to mind the statement of a newspaper reporter, who in an article in the San Antonio papers, referred to me as the "Father Confessor" to the veteran. The point I wish to emphasize is that if the school is to do its job of training, hold the veteran in training and provide satisfactory training, it is necessary that the school maintain very close contact, know the problems of the veteran and refer him to the proper agencies for the services he may need when his problems are other than training problems.

In my present employ, as Senior Training Officer for Trade and Industrial Education with the Veterans Administration, I find the problems no different from what they were in my previous employ. However, in my new activity, my work has been more of an overall activity. For the past few months I have been working with the vocational schools and colleges in the state, advising and assisting them in the organization of their terminal courses for veterans and recommending approval of such courses when the facilities of these schools and the training program is such as to meet the requirements for training in a given employment objective. I am sorry to state that the schools have been slow in getting ready for the training of the boys who come back. This may not be the fault of school administrators but rather the result of lack of equipment and a shortage of qualified instructors. Now that many capable men are being discharged from the armed forces and surplus war emergency equipment is being made available, the shortage in school training facilities may be relieved.

The problem, as I see it now, is to provide terminal vocational trade preparatory courses in the vocational schools apart from their regular program and on a sub-college level in the junior and senior colleges. If provided by the junior and senior colleges, these could very easily be made non-credit courses. There is a very definite need for such courses now and the need is increasing daily. As I mentioned before, we find the young veteran of 21 to 23 years of age to have matured mentally to 25 to 28 years of age. He does not care to enter a vocational school on the secondary level where he would have to mix with the youth of those schools. We know that he is no longer interested and wants to get away from the pranks and play of the youth of high school age. There is also a need for the older veteran who could not "fit in" on the secondary level even if he is willing.

A few of the colleges of the state have been quick to recognize this need and have set up sub-college terminal vocational courses for those who cannot qualify for college entrance and for those who can qualify but prefer a terminal vocational course. The offerings by such schools and such colleges at this time are definitely not sufficient to meet the demand, all of which means that we have to resort to the next best thing in many, many cases, this being straight on-the-job training. We now have approximately 1600 (September, 1940) taking their training this way. (3,000 to 4,000 now.) I think we all recognize that on-the-job training is sound, however, I also think we all recognize that on-the-job training in itself is not sufficient. The shortcoming of this method of training is that there is no definite organized and planned system of instruction. There is no definite standard by which we may measure the achievement of the learner or keep a record of his progress. The man under whom he may work may be thoroughly qualified for the job he is doing but a miserable failure in imparting to the learner the information the learner may need. As an example of this, almost daily we have one or more veterans come to our office and complain that they are working daily but not learning anything. There is no plan whereby the learner may gain a knowledge of the related and technical subjects for the job or if he does gain this information it may be properly put over and may not, all of which means that the training received is practically all on the manipulative side only. Therefore, I believe that the present need for the training of the veteran offers a challenge to the schools of the state. I feel that we have a responsibility to the veteran whether he be in need of rehabilitation because of a handicap or whether he be in need of education and training with no physical handicap. And, so the question is, do we recognize this responsibility and if so do we accept the challenge? If we accept the challenge then it becomes necessary that the vocational schools, junior and senior colleges of the state organize terminal vocational courses to provide the proper training for the boys who come back.

## Problems in Psychiatry in the Rehabilitation of the Ex-Serviceman

GUY C. RANDALL, Lt. Col., M.C., A.U.S.

The problems in psychiatry in the rehabilitation of the ex-serviceman are being learned by many for the first time. Some, however, recall the subject following World War I, when statistics show that several months after the end of the war there were more psychiatric problems in the community than there were at the height of combat. The question then comes up as to how the present psychiatric problems differ. There have been psychiatric problems for thousands of years. In fact, in reviewing history there are found references to this in Greek Mythology in such quotations as, "frenzy affecting heroes," and in 1500 B.C. it is written, "The heart grows heavy and remembers not yesterday."

Hippocrates, 400 years before Christ, accurately describes certain psychiatric phenomena and in the Bible, specifically, in the Book of Matthew and Mark, we find several references to psychiatric problems.

In considering the present subject it is questionable whether the problems encountered are different from those of the past. It was only last week that an Officer told me of a clothing establishment where the proprietor was overseas and wrote back to his wife and said, "When V-J Day occurs, throw all of the military clothing which we are selling into the street for all who may have it." When V-J Day occurred, his wife did as she had been asked. That particular individual has his clothing store to return to. He may be somewhat eccentric or hypomanic; he has, nevertheless, a business; had a business before he entered the service and will have one to which to return. We do not have to worry too much about his psychiatric adjustment. There may be some minor adjustments but he is returning to his business. A boy in my office last week, who had returned from overseas with a minor neurological condition, is waiting only for the time when he can be discharged so that he can return to his farm, as he wants to return in time to make plans for the coming year. There again, there will not be too great an adjustment. This type of individual does not want to hear, discuss, or hear discussed the experiences which he has seen and had overseas. On the other hand, there is the boy who has not had a job. He had not finished his education when he was inducted and he will have to return, either to take up his education as an older man studying with younger individuals, or will have to give up what educational experiences he should have and which he had previously planned, and start a business career. I recall very distinctly three young men, who in 1917 were roommates. All enlisted at the same time; one went overseas and drove an ambulance through the campaign in France. Another went overseas with the Infantry; the other was stationed at a local post. After the war, one boy lost what ambition he had to return to Medical School. He could not settle down but he finally returned to a small town and went into business with his father, and at the present time has made excellent adjustment and is one of the leading merchants, operating a well established market and grocery store in that town. The other, who had not been overseas and had not had as restless a career, continued his medical studies and returned to school. Both of these individuals have adjusted well in their way to their environment. The third individual, who had also gone overseas, had become frightened, had developed a severe anxiety state because of the bombing and other battle experiences, and whenever a shell burst, began breathing quickly and developed hiccoughs, which incapacitated him for his work. Upon his return to civilian life when under any special stress or any sudden noise, he continued to have hiccoughs. Many individuals will go through the same experience, one develop a nervous phenomena and the other does not. One of these three individuals requires treatment and has required treatment throughout civilian life, from the time that he returned from the war in 1918 to the present time, but he has made an economic success in life. All three have adjusted to their environment.

The same is going to be true in this war. First, a review and analysis of what is meant by a psychiatric problem must be made. All know that the true mental disorder is one where the person has a psychosis. It is most unfortunate that the terms "psychosis" and "psychoneurosis" are so nearly alike. It is known that psychosis means the true mental breakdown; that psychoneurosis means the person is having a nervous breakdown. Fear, which is continued beyond what is ordinarily considered normal for the individual. Anxiety, which is also beyond what is ordinarily considered as average. Depression, apprehension, etc., with all the accompanying ailments of shortness of breath, profuse perspiration, increased pulse rate, tremors, indigestion, diarrhea, etc. Again we must bear in mind the fact of the narrow line between the psychoneurosis and normalcy. A patient who is having a psychoneurotic reaction is usually not having any symptoms which the normal individual does not experience at times, but their normal feelings of fright, fear, anxiety, depression, etc. which are average are merely increased or prolonged enough so that the individual will require some advice. A majority of the patients who have broken down during combat or during the stress of war or regimentation, are going to be returned to the community by way of hospitals. They will have received rehabilitation and treatment as outlined by one of the previous speakers, namely, Capt. Bourque. Patients who come to the Neuropsychiatric Department receive various types of therapy which in many instances can be continued in various recreation and health centers, for instance, the Occupational Therapy, Recreation Therapy, Social Therapy, Information Therapy, Group Therapy, Physical Therapy, Special Muscle Training, and other allied therapeutic procedures. In other words these patients have received the best advice that the Army can give them. These soldiers will return to the community and will have had enough of a background, psychotherapy, and other forms of treatment and training so that they will know what to do. They will have already been rehabilitated enough so that they can continue without special advice in the community. They will be more apt to succeed in their rehabilitation than the soldiers who have come back from overseas and have been suddenly discharged from the Army into civilian life. It doesn't make much difference whether the person is an ex-enlisted man or an ex-officer. He is still going to find a great deal of change and disillusionment. Many of these patients are coming back as I have heard both officers and enlisted men say, that they feel they are heroes. They expect that the community is going to accept them as heroes, but how quickly the disillusionment occurs when they return home and, many say, "The people where I came from don't even know that there was a war". Some parts of the country are a great deal more war conscious than others, but there is no doubt but that the returning soldier feels that he is more of a hero than the civilian population is going to accept. I wish to illustrate by an instance told me a few days ago by one of the Neuropsychiatric instructors of nurses at McCloskey General Hospital. She told how a certain nurse of hers had been in the Army and heard of the high fees that some of the nurses were earning in civilian life. This nurse was about ready to return to the community. She had made no plans for the future. She had only been looking forward to leaving the Army. She was discharged, and went home, lived a few weeks with the extra money she had received and finally her folks said, "Well, daughter, it's about time you start out to make your living." She suddenly came to the realization that she was not a heroine. She had done a job the same as some of the people back home had been doing and now she had to settle back to an everyday sort of world where there was no glamour, no soldiers, no uniform, no war. In other words, she suddenly transferred from a world where the nation was at war but doing everything possible to make her life easier to live, to a life in a cruel world of reality. Fees were not as large as she had expected and she finally took one of the first jobs that came along. She was still dissatisfied. She was more of a psychiatric problem at that stage than she had been in the Army. There, she was considered an average individual with average adjustments. My friend who is in the Veterans' Administration states that he is receiving a great many patients at the present time who have returned from overseas and have been discharged on points in a hurry. The boys land from an active Army career into their civilian life without having had special adjustment and when they meet with reality, they soon begin to have feelings of apprehension, anxiety and depression. They actually seek the Veterans' Administration for relief.

What can we do about all of this? I suppose that is a question which is being asked more and more. Treatment is no different now than it has been for the past many years. New terminology, yes; but very little difference in the treatment. The symptoms are the same, whether they are called "shell shock," "physical exhaustion," "combat fatigue," "anxiety state," or what not. Therefore, we still have to treat these cases from a symptomatic point of view; treat as an individual and as a whole. Each person has to be an analyzed individual, considering his environment, his personality, his family background, his cultural interest, and everything that this person comes in contact with must be analyzed before we can definitely set up an outline for his future. He has been in the habit of regimentation. His entertainment has been mapped out for him. His day's work has been mapped out for him. His education has been mapped out for him. His religious activities have been mapped out for him. Suddenly, tomorrow, he finds himself on his own, a civilian. The three or four years of having everything served to him on a platter is ended. If he has a definite plan for the future, he is all right; he will be taken care of and there is nothing for the community to worry about; our Government will take care of him. If, on the other hand, he has not, then the community has got to set up centers where they can take this individual to a psychiatrist, psychiatric social worker, clinical psychologist, industrial psychologist and so forth, analyze the boy's problems and find out exactly what should be done, and have somebody there who can advise him. A complete psychiatric checkup should be made. The Veterans' Administration, to which every boy or girl has a right to apply, is set up to give all the expert advice the Veteran may require, psychiatrically. I do not believe that this problem is something which we can put down and say, "This is what we're going to do for the rehabilitation of the soldier who comes back." The amputee has a special problem; the paraplegic has another special problem, but all of these men have been hospitalized and will have definite specialists follow them to completion. The one in whom we are especially interested, in the community, is the man who is going to have the hardest time adjusting. He is the man who has not been hospitalized but suddenly was discharged from the Army into the community with no plans for the future, and he is the one who must receive the care in Centers as mentioned before, in a center where the boy can feel free to come for advice. That center should have a well-trained psychiatric social worker who will make the contact or rapport with him and see that he or she is sent to the correct center for adjustment.

## SYMPOSIUM ON THE TREATMENT OF THE MENTALLY ILL

### Problems in the State Hospitals

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The eleemosynary system of Texas consists of 21 separate institutions. Of these, 9 are devoted entirely to the care of mental, nervous, feeble-minded and epileptic patients. These institutions care for 17,000 of the state's wards. There are seven of these institutions with a capacity ranging from 2000 to 3000 and two with a capacity of around 500 each.

The operation of our state hospitals over the past few years has been a most difficult task. In spite of shortages of personnel and shortages of material for buildings and upkeep we have seen many forward moves.

For some fifteen or twenty years one of our most troublesome problems has been that of the "waiting list". Because of lack of space and other factors, a person making application for admission to a state hospital simply had to wait his turn. If he happend to be so ill that he was unable to wait at home it was necessary to place him in jail.

In 1937 the first attempts were made to do something about this waiting list. At that time the Board of Control appointed Dr. Charles W. Castner as Chief of the Eleemosynary Division. One of his first duties was to conduct a survey to determine the exact size and scope of the problem. It was determined that there were 908 persons in the state who had been adjudged incompetent because of mental illness and who were awaiting admission to an institution.

Out of this work came the decision to open the State Hospital at Big Spring, Texas. The new institution was planned, constructed and opened shortly thereafter. It was soon filled to capacity and the problem of the "waiting list" remained.

Little further was accomplished until 1943 at which time a second survey showed about 700 persons in the jails awaiting admission to state hospitals. At this time the Board of Control took vigorous action and by the end of the year had admissions on a current basis. This remarkable accomplishment was made possible by the construction of only one ward building at the Terrell State Hospital and the renovation of the Texas Confederate Home for men.

The problem of building, renovation and maintenance has been one of tremendous importance for the past few years. The war caught the System with an extensive building program in the planning stage. Appropriations were lost because of inability to utilize them. Not only was new construction curtailed, but maintenance was cut down to a bare minimum. In fact, we have all been aware that we couldn't take the "stitch in time." We knew that eventually we would have to spend many times over the cost for a repair job. This, simply because labor and materials were not available for current repairs.

No discussion of the problems of operation of the state hospitals would be complete without a thorough study of the personnel problems. From the accumulation of experience we have come to know about the number of attendants, physicians, nurses and other help needed to run a state hospital. The appropriations provide for one physician for each 250 patients. This is a fairly good ratio. During the past few years we have not been able to get those physicians. The tremendous requirements of the Armed Forces so depleted the available men until the system suffered a great deal. Some institutions have had as few as one doctor to every 850 patients. This situation was, of course, deplorable; it could not be helped. We would have been in worse shape had it not been for the patriotism of the older men who had either withdrawn from practice or had drastically limited their work. These practitioners responded to our appeals and came back into active work to assist the state hospitals. They were handicapped; most were up in years and many had had no experience in psychiatry. Nevertheless, they kept the medical program moving.

Besides physicians there were many other personnel problems. Most institutions had no nurses, or at most only one. Psychiatric attendants were impossible to secure. To cite examples, the San Antonio State Hospital operated for many months with as low as 60% of its normal quota of attendants, and the Big Spring State Hospital with 62.3% of its normal quota. These attendants usually were not skilled workers in any one field. We attempted to train them, but war work and higher salaries won out.

Besides the above helpers who are obviously needed in a hospital, let us stop to consider the long list of other personnel required. In order that the plant could function, we needed: dentists, dietitians, druggists, cooks, bakers, plumbers, electricians, brickmasons, carpenters, bookkeepers, stenographers, medical technicians, social workers, occupational and recreational therapists, poultrymen, dairymen and many others.

It is the obvious function of a hospital to treat its patients. The treatment of mental patients may be by one of the special treatments. These are insulin, metrozol, electro-shock or sleep therapy. On the other hand there are in our state hospitals many who cannot be expected to improve by any one of these methods. For the group of patients we must institute a continued care program.

Under the conditions we have described above concerning our personnel problems it is understandable that we have not been able to maintain a treatment program up to our pre-war standards. Insulin treatment, for example, requires a well trained and experienced team. To be given otherwise it would be dangerous. The only intensive type treatment we have been able to give over the entire war period has been electro-shock.

Our continued care program has also suffered. Such a treatment regime is based on such therapeutic adjuncts as occupational therapy and recreational therapy. In none of our hospitals have these departments been closed, but they have had to be drastically curtailed in all. Fortunately, the nature of the organization of our institutions is such that they can recover from these difficulties rapidly.

Another of our major problems is that of commitment. Texas is one of the few states still requiring a jury trial for commitment to a state hospital. Many attempts have been made to change this feature. At least five laws have been passed in an attempt to make admission without jury trial possible. Of these three have been declared unconstitutional and only the temporary or 90 day commitment and the voluntary commitment laws remain in force. It appears to be impossible to enact a law which will suit our purposes and at the same time not conflict with the constitution. We have become convinced that our only hope is to effect a change in the constitution to the extent that persons may be sent to hospitals for mental treatment by other means than a jury trial.

One of the chief worries of any state hospital administrator at this time is the "difficult to move" population. All of us who have been in state hospital work have seen innumerable examples of patients with no place to go. The patient is brought to the hospital and placed under treatment. In time he shows improvement and recovery. At first glance it would seem that he would be immediately released. It doesn't work nearly so simple as that.

To begin with his relatives must be willing for him to come home. There are an astonishing number of families who refuse to take the patient out. They will stoutly maintain that the patient is still ill; "once crazy, always crazy." They will plead fear and say that the neighbors would not tolerate his return.

On the other hand, we often see the family ready to accept the patient, only to have a county official block the release. He will go so far as to say that the community is afraid of the individual and that release by the hospital will only mean return by the officers.

Of course, we have the technical right to release any patient if we deem him ready to leave. To pursue such a course would be unwise. The patient would have little or no chance to remain well if he had to go back to unsatisfactory surroundings. At best he is still convalescent. The strain of a hostile environment would be too much for him to stand.

This last problem is not one that we of the state system can solve alone. It requires community education. It is essential that the population as a whole take cognizance of our problems. As has been repeatedly stated, "The state hospital has no public supporting group." It should have—the group should be the people of Texas.

## Modern Theories on the Etiology of Psychiatric Disorders

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The great common basis for modern psychiatric thinking is the attitude of Adolph Meyer who incorporated his feelings and beliefs into a body of thought usually dubbed psychobiology. The basic thesis in psychobiology is that a human being represents an integration of atoms, molecules and substances which in proper organization form certain organs which in turn function as an organized unit called a living man. From this functioning emerges the phenomena known as behavior in its various aspects. Thus psychobiology becomes a study of the behavior of man and psychiatry a study of the cause and treatment of pathologic behaviors of the person. An important part of man's behavior is the adaptation of his activity to the natural forces about him and to the cultural activities of his fellow man. It is believed that disturbances within the organism itself or between the person and his environment, or between individuals, may be productive of difficulties in behavior and as such play a role in psychopathology. We attempt to understand the various psychiatric reactions as interaction between the individual and the situation in which he finds himself, the final reaction depending a good deal upon the variables in the individual and the situation. It is believed that an individual may cope with a situation which he meets by increasing his activity in order that he may overcome the difficulties of the situation or by changing his environment, that is, simplifying it until his capacities may allow him to cope with the situation in which he finds himself. Thus, an individual lacking in capacities of various sorts may have difficulty in adjusting to an ordinary situation requiring that capacity. (e. g. Blind man shooting craps.) On the other hand, a person of ordinary or superior capacities may also have difficulties in adjusting if the situation is unusual and beyond his capacities. (e. g. Anxiety of combat pilots.) If the individual and the situation are such that the person can handle the matter then the reaction is one of adjustment or health. If, on the other hand, either due to deficiencies within the individual or unusual difficulties in the enviroment or a combination thereof, the person cannot meet it with satisfaction, the reaction is one of maladjustment. Maladjustment may be manifest in several ways but always through a disturbance of behavior in some form. From the psychiatric point of view the maladjustments are usually classified according to seven major subdivisions.

First, the organic diseases or reaction types in which the maladjustment is due to some defect in the tissue of the nervous system of the patient himself. Any disease or injury which produces irreversible changes in the brain may produce mental symptoms. Examples of this are individuals who are mentally deficient due to birth injury or congenital aplasia, and individuals who by nature of disease such as syphilis or encephalitis have lost the efficient functioning of their nervous systems. Another common group are those with mental changes due to the wearing out or changes incident to advancing age such as cerebral sclerosis and senile deterioration. Another large group are those patients in which the nervous system has been accidentally injured.

The second group of reactions are the toxic states or poisonings of which drug addiction and alcoholism are the most common ones encountered in our society. The remaining groups are the so-called functional reactions, so named because the mental processes of the patient are functioning inefficiently and in an abnormal way, yet examinations fail to disclose any demonstrable clinical, pathologic, or toxic change by present diagnostic methods. These functional reactions are the manic depressive or affective reactions, the schizophrenic reactions, the so-called constitutional psychopathic inferiority states, a rare disorder known as paranoia, and the minor reactions known as the psychoneurosis.

The etiology of the organic reactions is easy to settle. These are due to organic changes in the cells of the nervous system itself and in general the mental changes are in proportion to the severity to the organic reaction. This is true particularly in so far as the intellectual functions, such as memory, retention, judgment, and so forth, are concerned. Many of the symptoms in the organic reactions are colored by the person's previous personality pattern but these symptoms do not vary with the severity of the organic process. There is, however, one very interesting problem as yet unanswered concerning the etiology of the organic state. This has to do with that form of syphilis of the nervous system known as general paresis or dementia paralytica. In this reaction the spirochaete lies dormant in the body anywhere from six months to thirty years but in the average case fifteen to eighteen years before the symptoms develop. No one has explained how these organisms can lie dormant in the body so long before invading the brain. The two theories are: that some persons have an area or zone of minor resistance permitting invasion, and second that there are so-called neurotrophic strains of the spirochaetes. These theories leave unexplained the long latent period between primary infections and parenchymatous involvement.

The toxic states are also relatively easy to understand and here also the toxic changes in terms of edema and swelling in the brain itself closely parallel the severity of the psychiatric symptoms and the toxic mental symptoms disappear as the physiologic function of the brain returns to normal. This has been domonstrated in many ways, the most recent and interesting experiment being carried out by Engle, Romano and co-workers, showing that abnormal electroencephalograms are found in patients with delirium. Along this same line, Ruskin and myself have demonstrated that certain cardiac patients with decompensation will begin to show abnormal electroencephalograms even before any delirious systems appear.

In the functional reactions there is still considerable debate and considerable research as to the true nature of these illnesses. Psychiatric opinion is divided as to whether or not the illnesses are principally psychologic in origin or whether they are principally of an organic or physiologic origin. The former opinion has in general characterized American psychiatry while the latter opinion has been more typical of German and other European writers. There is much evidence in support of both views and it is probably true that the final answer lies in a combination of the two etiologic agents. It is equally true, however, that there can be no function without structure and the functional disturbances are to be finally understood in some structural aberration or some physiologic dysfunction. I will discuss some of the more interesting findings for the major reaction types but time nor space would not permit anything even approximating a total presentation of the evidence available.

The so-called affective disorders or manic depressive psychosis are one of the more common or disabling psychiatric disturbances of the major types. There is considerable difference of opinion as to the true ideology of these illnesses. The schools of thought may be roughly divided into two groups. One group believes that the manic depressive state as well as the other emotional disturbances spring from a constitutional basis which has its roots in inheritance and that the psychosis appears in certain individuals who have predispositions that have been fairly well delineated.

Vogt determined the existence of the psychosis in 20 per cent of the patients' parents, and in 35 per cent of their siblings. Both Kraepelin and Reiss emphasize the predisposition and in 60 to 80 per cent of their patients they were able to discover depressive, manic, irritable, and cyclothymic prepsychotic make-up. Pollock, Malzburg, and Fuller have made the most extensive and accurate study of inheritance. They state, "there appears to be, therefore, a familial basis for the development of mental disorders in many cases, though the underlying laws of their manner of transmission are not yet understood." Many investigations have led to the repetition of the opinion that among the more potent predispositions to manic depressive states are the somatic characteristics of the so-called pyknic or broad habitus and in the psychologic traits of what is known as the extrovert personality.

The second large school of thought as to the etiology of these disorders is based on analytic psychology and, in brief, teaches that the manic depressive states as well as the other milder depressive states are due to psychogenic disturbances brought about by the individual's difficulties in adjusting his instinctual strivings to the demands of the world about him. It is thought for example that the depressions are examples of the super-ego meting out punishment to the individual for previous transgressions of his own moral and ethical code. The manic phase is due to the temporary overthrowing of the super-ego's supervision of his instinctual strivings and his spree-like gratification of his id impulses. Many careful biochemical studies have been reported in the manic depressive state. In a review of the literature in these cases McFarland and Goldstein noted that there is a tendency for the manic depressive to have a slightly increased blood sugar during the manic phase and to be defective in their sugar tolerance during the depressed phase. They also noted that the manic has a slightly increased blood calcium and that lipoids of certain types are rather high. They believe that this disturbed carbohydrate and lipoid metabolism is the most striking finding. Other authors report disturbances in the basal metabolic rate and the detection of albuminuria, disturbances in pulse rate, blood count, and so forth, in the manic depressive phase. All of these findings are inconstant with patients suffering from the same type of disorder and are probably best understood as the body's response to the tension and anxiety accompanying the mental symptoms. Endocrine dysfunctions have been considered as the cause of the manic depressive disturbances and research on the endocrine levels and the endocrine dysfunctions in the manic depressive state make up a vast bulk of literature. The evidence is still inconclusive but the bulk of evidence proves or tends to prove that the endocrine level shows some minor fluctuation during the manic depressive state but has no specific influence on either the causation or treatment of the disorder. There have been many favorable reports of the successful treatment of the depressed cases with various sex hormones. In many instances the preparations were physiologically inert. In others, treatment is carried on so long that a spontaneous remission cannot be entirely ruled out as the cause of the improvement. In spite of many careful and detailed post-mortem studies no definite neurologic or somatic disease has ever been discovered in the manic depressive state.

The largest group of functional mental disorders are the so-called schizophrenias, or sometimes known as dementia praecox. Each year, at least 30,000 persons in the United States alone develop this condition and while more persons occupy public hospitals for this condition than for tuberculosis, poliomyelitis, and cancer combined, the etiology is unknown and less than one per cent of the public money spent in caring for these patients is spent for research into the cause or more effective forms of treatment. The theories of the etiology are many and are notable examples of the verbal dexterity of most psychiatrists. At one time it was felt that dementia praecox or schizophrenia was inherited and we see an occasional paper tending to show the inheritability of this disorder but carefully studied series by competent statisticians fail to confirm this view. Pollock, Malzburg, and Fuller state, "It is clear, therefore, that though there is probably a familial basis for the origin of many cases of mental disorder, in the family stock of probands of dementia praecox the observed frequency cannot be described in Mendelian terminology." Many psychiatrists believe that schizophrenia is a functional disorder, a faulty reaction to life experiences but a few think schizophrenia is an organic disease process of unknown cause and unknown pathology. The functional theories have distinguished American psychiatry under the stimulus of Meyer, Freud, Hoch, White and their pupils. The basic view is that certain individuals meeting life experiences to which they have difficulty in adjusting, withdraw or compromise in an unsatisfactory manner. The person, being dissatisfied, seeks satisfaction in fantasy wherein he says or does the things he wished to do in the original setting. Succeeding difficult situations are handled in a similar manner. As time passes and difficulties accumulate the individual depends to an increasing degree upon himself and his own fantasies for his satisfactions from life. At last, a point is reached where these fantasies assume a dominant role in his life and environmental events are interpreted in terms of the fantasy. The person is said to be living in a world of unreality, his own ideas, wishes, and beliefs are attributed to the people in his environment. This results in difficulty in adjustment to families and friends and neglect of social obligations. A longitudinal study of the development of such cases explains the development of the delusional system and trends, and the misinterpretations of what goes on about him, can be understood if the data available is sufficient. It leaves unexplained, however, why under environmental stress the individual reacts in this manner. To say it is a constitutional predisposition or in other words the nature of the bruit, leaves one with another explanation but unfortunately leaves the question unanswered. Psychoanalytic groups have pursued this idea a little further, stating that due to earlier difficulties in emotional adjustment these patients cannot form emotional ties to persons or objects other than themselves. This difficulty in forming a transference to the analyst makes analytic therapy prolonged and at times impossible. The disturbance in this capacity to develop emotional drives or urges toward other persons, explains much of the emotional pathology in schizophrenia. The term used to describe this state is "regression to the narcissistic level" and implies that the patient finds satisfaction for his emotional strivings within himself. It also implies that the person has some difficulty in distinguishing between that which is himself and that which is the world about him, a disturbance of ego reference. The facts are that these theoretical postulates coincide very accurately with the symptomatology seen in schizophrenia and contributes much to our understanding of the symptoms we encounter. Unfortunately, we still come back to our first question, why must the patient adjust in this way? The manner of formation of the symptoms and their meaning can be explained, but we do not know why the patient has a need to develop an illness to solve his problem. The organic theories have been most popular in Europe. Much material has accumulated but the findings were inconstant and in most instances the clinical features of the particular schizophrenias studied are not clearly indicated. Many workers have reported a correlation between schizophrenia and the so-called linear or asthenic or leptosomic body type but every psychiatrist has seen many typical cases in persons of athletic or pyknic body build. One may say that there are more linear than broad persons suffering from schizophrenia but a linear habitus is not essential to one of this group of diseases. Pathology in the brain itself has been reported by many laboratory workers. Nissl reports cortical degeneration, Josephy found cellular changes in the third and fourth layers of the cortex, and Niato confirmed these findings. Funfdeld described lipoid sclerosis in the third cortical layer and lipoid deposits in the optic thalmus. Marcuse claims to have found double neuclei and lipoid degeneration in some of the thalamic ganglion cells. Kitabayashi reports characteristic changes in the choroid plexus. Oppenheimer demonstrated ameboid glial cells in some acute cases. Recently Penfield, Elvidge and Reed have demonstrated a glial reaction in the white matter of biopsy specimens removed from both acute and chronic cases of schizophrenia. Elvidge and Reed believe that the changes are due to disturbances of the association pathways and report similar findings in manic depressive patients and in patients in a postepileptic stupor. They found no such changes in epileptics who were mentally clear and no such changes in the control patients. Goldstein, Nissl and Orvel also found a glial reaction in the white matter and the deep cortical layers plus an increase in the lipoid content of the ganglion cells. Freeman found fat in increased amounts from the cells of the basal ganglion and calcarous degeneration of the blood vessel in many cases of schizophrenia. Freeman also found a deficiency of iron in the cortical ganglion cells in schizophrenic patients of all types except the paranoid form. Dunlap's famous report did much to discourage further pathological studies in America. His report concludes, "For us, the changes in schizophrenia are not only inconstant, nonspecific, but they are such as may be found in any series of control cases." Many workers, notably Spielmier believed that the pathology is present but cannot be demonstrated by present laboratory methods. He states, "There are many cases in which the anatomical analysis has revealed no deviation from the norm. It does not appear justifiable to conclude as many investigators have done and such a negative finding renders apparent the functional rather than the organic nature of the process of dementia praecox."

Other studies show more generalized pathologic and metabolic disturbances. Kraepelin believed that the disease was due to metabolic autointoxication resulting from disturbance in the gonads. Mott reported testicular and ovarian atrophy with the attendant endocrine dysfunction and final brain pathology in schizophrenic patients. This work was severely criticized and Morris pointed out that the changes were probably unrelated to schizophrenia. Recently Hemphill, Reiss and Taylor report a special form of atrophy of the tubules of the testicles in many schizophrenic patients. They did not encounter these changes in control subjects or in patients suffering from other types of mental disorders. These studies were made on biopsy specimens taken from patients in good physical condition. They found the atrophy varied in severity with the malignancy of the psychosis and did not vary with the duration of the illness, the patient's age, or the patient's body type. The atrophy was rare in the paranoid form of schizophrenia and was never severe in this group. They conclude that the testes change is not the cause of schizophrenia but it is evidence that a complex change exists of which it is one sign not related to mental trauma or masturbation. They found that the atrophy was not accompanied by a decrease in seventeen ketosteroids or by loss of secondary sex characteristics. They treated eighteen cases with follicle stimulating gonadotropic hormones from pregnant mare's serum but the results were far from remarkable.

Hertz found shortening of blood coagulation signs. Bowman has reported evidence of polyglandular disorder and Henry found definite changes in gastrointestinal motor function, especially in the acute cases. These changes were similar to those associated with fear or rage. Malamud and Rothchild found decreased permeability to bromides and the blood cerebral spinal fluid barrier in sixty per cent of schizophrenic subjects. Wikoff, Marcum, and Marvin found the bromine content of the blood lower in schizophrenic cases than in control subjects living in the same city and drinking water from the same source. Friedman, Emerick, and Thale report a smaller rise in cerebral spinal fluid pressure from histamine injections in schizophrenic patients than in their control series. Katzenelbogen, Soloman, and Snyder found both serum potassium elevated in five patients in a series of twenty-nine schizophrenics, and states a variation is due to emotional state. Harris found thirty-three per cent of his schizophrenics had serum with a pronounced antagonistic effect on the action of insulin. Meduna found this abnormal reaction to insulin in sixty per cent of his schizophrenic patients. One of the most widely entertained theories and one in which I have been extremely interested is the disturbance in glucose and oxygen metabolin. The use of shock therapies first focussed the attention of various workers on the fact that the beneficial effect if due to some physiologic alteration will probably be in terms of an alteration in glucose metabolism or an alteration in oxygen utilization because these are the two things which the various types of shock therapies have in common. In insulin shock therapy the glucose metabolism is altered by depletion of the blood sugar and oxygen utilization in the central nervous system is correspondingly decreased. In convulsive shock therapy the convulsions produced a period of apnea and cyanosis and therefore a disturbance in oxygen utilization. Many workers have been interested in this particular phase of the problem and von Meduna, the originator of convulsive therapy, has probably made the most progress and the most careful studies to date. He has shown that the disturbances in the carbohydrates metabolism are essentially similar in both forms of shock therapies. The principal criticism of all of these studies is the fact that the clinical evaluation of the patient is usually inadequate. It is exceptional for the authors of these various physiologic, pathologic, and chemical studies to give the clinical criteria upon what they base the diagnosis of schizophrenia, yet the ordinary textbooks usually describe schizophrenia as being a group of related disorders. Every clinician working with these reactions will recognize and teach his students that there are various types of schizophrenia and that the prognosis varies in the various varieties. In spite of this general knowledge most authors fail to mention which diagnostic subclassification the patient belongs in and do not establish clearly on what ground the patient is called schizophrenic, how long he has been ill, what they have had in the way of previous treatment and so forth. These omissions make the bulk of the studying done to date without value in my opinion. There is an urgent need for a careful, orderly approach to these problems through the combined efforts of physiologists, chemists and well trained psychiatrists. I believe that definite clinical criteria should be set up so that one would speak of studies performed on schizophrenia showing accurately described defined symptoms.

The minor reactions or so-called psychoneurotic states are much better understood from an etiologic point of view than the major functional psychoses. It is generally assumed that the symptoms of the psychoneurotic patients are due to psychologic or environmental disturbances which in turn bring about certain somatic and physiologic disturbances which produce distress. In the neuroses it is usually possible to trace the development of the various symptoms to definite and specific environmental or emotional upheavals. The exact ways in which these things work have been subject to some differences of opinion from time to time, but at present the bulk of psychiatric opinion believes that the psychoneurotic symptoms are best understood as the patient attempts to arrive at some solution of a conflict between his own basic urges and strivings and the demands of his environment and the moral code of his group. The most widely accepted group of ideas at the moment are those of the psychoanalytic group, as first promulgated by Sigmund Freud and is considerably expanded and elaborated by his pupils. Almost all practicing and theoretical psychiatrists utilize at least some of Freud's basic principles and concepts.

The most interesting research in this field of medicine is the role that so-called neurotic disturbances play in producing somatic disease. Almost every clinic in the country is doing some work on these things, although probably the best work is being done by Flanders, Dunbar, Draper, and their group at Columbia in New York and by Wolf and his group at Cornell and by Weiss, English and their group at Temple in Philadelphia. These disorders in physiology produced at least in part, by psychologic disturbances, are called psychosomatic illnesses.

The first large group of psychosomatic disturbances occur in patients with symptoms referred to one or more of the body systems but without demonstrable evidence of somatic pathologic change. And the second large group has to do with patients with definite structural alteration, thought to be at least in part due to psychologic disturbances. The first large group comprises those things just described as the ordinary psychoneurosis. In the second large group we find symptoms similar to those seen suffering with anxiety but with definite structural lesions in some body system and in which the psychogenic factors are thought to be an important part of the etiology. Many studies have been made on peptic ulcer, hypertension, chronic bronchial asthma, the rheumatic disorders, and the hypertensive cardiovascular disturbances. Considering these disorders, two quotations are apt. Nolan Lewis, has stated, "Those who neglect to take into account the psychological factors in disease should be reminded that psychological energy acts through physical structures and produces physical effects as otherwise phenomena could not appear." Flander Dunbar has stated, "At least much too often an ideologic relationship between the psychic problem and illness has been assumed rather than demonstrated." There have been many studies devoted to detailed elaboration of the life history in the emotional vicissitudes of the subject under consideration. The careful correlation of these psychologic disturbances and the physical factors produced plus the constitutional elements present has led to certain types of characteristic psychodynamic profiles found fairly consistently in these somatic disorders. The most extensive work along this line has been done by Dunbar and her group at Columbia. For example, they found that their patients suffering from fractures tended to be rather decisive persons who focussed most of their attention on day-to-day pleasures who had emotions to people and concrete situations rather than about ideals and philosophic concepts, showed little interest in power or long range goals and as a result have unstable work records although their income has a good average but is intermittent with long periods of being out of work, frequent changes of occupation, and yet a good income while working. They showed rather characteristic irresponsibility and lacking of planning. It is of interest that this fracture group, which has shown a definite profile, was originally included in the study as being a good control series. Coronary patients in sharp contrast to the above are individuals who show a profile characterized by compulsion to succeed through work and self-discipline. Their educational record is consistently good, their work record stable and persistent, and their income usually shows an increasing trend through the years. There is a high degree of planning and persistence in these individuals, they are usually well liked and socially gregarious, in many instances, forcing themselves into these social situations for the furtherance of their own ambition. They have a strong sense of responsibility. Closely related to this profile are the patients suffering from angina syndromes and the profile is essentially the same. Hypertensive cardiovascular patients are somewhat related to the coronary diseases, as one might expect, but show a more compulsive striving for advancement. They have occasional impulsive interruptions of these strivings. Their educational, occupational, and work records are inferior to the coronaries as a result of these impulsive interruptions of their efforts. They are often people who strive but fail to achieve, they are well liked, often drink too much, and often show sexual aberration in terms of impotency or ejaculation praecox among the males. Diabetic patients are still different, they show a good educational level but have a high incidence or nervous breakdowns in their history. The patients also show much social anxiety being superficially agreeable but deeply insecure, hypersensitive, and with many paranoid trends.

The analysis of these individuals shows prominent areas of conflict in reaction. For instance, the fracture patients show a high incidence of neurotic trace of an active and a social type. There is a common history of lying, stealing, truancy, sleepwalking, and sleep talking. They usually seek competitive sports, indulge in gambling, and yet have a deep fondage to religion which they seem to resent. The coronary patients on the other hand, have few early neurotic traits. They have a tendency to brood, keep themselves, have few hobbies in sports, principally because they spend most of their time in working. They are not religious as a group. Prior to illness they usually had a shock or incidence thwarting their ambitions and strivings. The angina patients as a group are more artistic and interested in cultural pursuits. Their attacks were in many instances precipitated by accidents or loss of loved ones. The hypertensive patients had few early neurotic traits but the ones present tended to be temper tantrums, nightmares, nail biting, and impulsive acts of aggression toward others. The passive tendencies in these patients were rather obvious combined with considerable hostility. Patients with peptic ulcer have shown a high incidence of hostility and anxiety as the commonest and predominant psychosomatic profile. The occurrence of these psychologic configurations in so many of these patients has, of course, led to the growth of the idea that the psychologic disturbances play an important role in the ideology of these disorders. If this be true, how can psychologic disturbance produce somatic pathology? From a physiologic point of view the pathology produced must be due to dysfunction in the autonomic and endocrine system as these are the links between emotional processes and physiologic function. Anatomically speaking, the areas involved must be the hypothalamus and cortex as these areas seem to be the principal central regulators of autonomic function. Having determined how such alterations in functions would be possible, the second question is, can such alterations in function produce somatic lesions? One is then forced to turn to experimental efforts to produce organic lesions by means of alterations in autonomic function. Extensive work along these lines has been done in the study of gastro-intestinal ulceration and in the fields of the hypertensive changes. It has long been known that central nervous system lesions could produce ulceration in the gastro-intestinal tract in man. This was first reported by Cushing in the case of a child who had been operated on for a tumor who subsequently devoloped a perforation of the gastro-intestinal tract. Keller, Hare, and D'Amour have produced acute lesions of the gastro-intestinal tract in animals by producing intraventricular hemorrhage or bi-section of the brain at the level of the chiasm. They have also produced gastric lesions by hypothalamic lesions in cats. Hoff and Sheehan produced multiple hemorrhagic erosions of the mucosa of the stomach by lesions involving the tuberal area in monkeys. Keller and D'Amour report similar findings in the dog and also show that the occurrence of hemorrhage into the mucosa was not prevented by section of the vagus fibers and that ulceration was not prevented if the sympathetic fibers were removed. Watts and Fulton found that gastric and duodenal ulcerations in monkeys were produced by extensive hypothalamic damage. They explained the lesions as being due to ischemia of the mucosa brought about by vasoconstrictor fibers. We must have evidence of experiments from nature and from the laboratory that organic lesions of the central system may produce ulcerative lesions of the gastro-intestinal tract. Miller and others have shown repeatedly that physiologic functions in the gastro-intestinal tract may be altered by emotion. One of the most conclusive bits of evidence that emotional factors by alternating autonomic function may influence the development of gastro-intestinal ulceration is found in the studies of Wolf and Wolff. In a patient with a gastric fistula, they observed that emotions of anxiety and hostility produce hypermotility, hyperemia, and small areas of hemorrhage in the gastric mucosa. They have further shown that these hemorrhagic areas ulcerate readily if exposed to gastric secretion and they have shown that the small areas of hemorrhage on exposure to gastric secretion produce more hyperemia and more hypermotility. A less conclusive but interesting study is one reported by Spicer and his co-worker who have shown that the incidence of perforation and hemorrhage from gastro-intestinal ulceration increased significantly during the London Blitz suggesting the role of emotional state in the cause and course of the ulceration of the G.I. tract. More experiments of the type of Wolf and Wolff are definitely indicated. At present, we can say that there is abundant evidence to show that autonomic dysfunction, whether organically or emotionally produced, can produce alteration in the function and structure of the gastro-intestinal tract. We have evidence that hostility, anxiety and aggression with a dependent attitude, are the personality characteristics most consistently found in persons suffering from ulcer. We also know that adequate treatment of these emotional states favorably influences the course of peptic ulcer; thus, the circumstantial evidence becomes rather convincing that ulcers are due to a specific type of emotional reaction in persons of certain constitutional and personality organization. To date, we have not produced ulceration by experimentally induced emotional state unless the work of Spicer may be accepted as such.

There is also evidence to support the fact that emotional changes may produce significant alterations in functions of the cardiovascular system but to date we do not have the complete answer to the cause of the hypertensive cardio-vascular disorder. The fact that emotional states may produce profound temporary changes in pulse rate, fainting attacks, blushing, and similar vascular phenomena has led to an investigation of what role emotional factors may play in the more chronic or pronounced changes in blood flow and distribution and vessel elasticity as found in the chronic states. Animal experiments offer interesting data. Fulton has shown that faradic stimulation of areas four and six of the cortex in cats and monkeys will produce a sharp rise in systolic pressure. This effect is abolished by general anesthesia or by local anesthesia of the cortex and is reduced but not entirely abolished by splanchnic nerve section or by destruction of the stellate ganglion. There are many reports on the role of the hyperthalamus in controlling the blood pressure level and its role in the production of hypertension. These reports vary considerably but in general indicate that stimulation of certain portions of the hypothalamus will produce an increase in blood pressure. Miller has made an excellent and rather complete survey of the literature on this subject. Allen has observed interesting differences in the blood pressure response to clamping the pedicle of the explanted kidney in dogs. He explains the difference in blood pressure response as being at least in part due to personality differences or temperament types of the dog. It should be borne in mind, however, that none of the above experiments produce in the animal conditions even remotely simulating essential hypertension, or the cardiovascular syndromes of man. It should further be borne in mind that essential hypertension has been produced experimentally by the Goldblatt preparation. On the other hand, hypertension has been relieved to some extent by the surgical removal of portions of the autonomic system in man, yet, the same operation in Goldblatt's dogs produced no lowering of the blood pressure. Farus, Yeakel, and Medoff have recently reported that they have produced hypertension by means of experimentally induced emotional trauma in gray Norway rats. It is interesting that the rats who show the hypertensive response to air blasts are those who had been previously selected on the basis of being emotionally unstable. They determined emotional rats from the nonemotional ones on the basis of the defecation response during two minutes spent in a strange storage pen on twelve successive days. The animals were treated to the sound of an air blast for five minutes per day five days per week for a minimum of 167 blasts. The unstable animals developed hypertension in all instances. The borderline and stable ones did not in most instances, and the unstable rats not exposed to the air blasts did not develop hypertension. The tension reported is a systolic tension of 160 to 180. Methods of taking this is not described, the duration for which the hypertension persisted is not noted but even so it is one of the first reports on production of hypertension in neurotic animals. Anderson and Parmenter have reported changes in the E.C.G. of some of their neurotic sheep which they suggest may be due to vaso-motor reaction of the coronaries and a decreased oxygen supply to the heart muscle due to fear of anticipated shock. Unfortunately, they do not report blood pressure changes in their sheep.

The above remarks are by no means to be considered a complete summary of the situation. They do, however, indicate the general natures of researches undertaken in this field. As is easily seen, many of the studies leave much to be desired in terms of control features and thoroughness. There is a fertile field for the collaboration of clinicians and basic scientists in the whole field of neuropsychiatry. The speaker firmly believes that only the collaboration of careful physiologic, biochemical and pathologic work plus careful clinical psychiatric examinations and tests by persons familiar with both the clinical and basic aspects of the problem will lead to any definite conclusions concerning the above factors.

## Community Measures in the Prevention of Mental Illness and for the Rehabilitation of Mental Patients Following Institutional Care

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(Copy of this paper available upon request.)

# SECTION IV. GEOGRAPHY AND GEOLOGY

## PAPERS

## Availability of Texas Surface Waters

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The development of a community, state, or nation stops when its water supply ceases to meet the overall demand. This statement is readily understood by those living in arid sections where special efforts are made to conserve water in the soil for crops, and in ponds or reservoirs for domestic, industrial or other uses. Industrialists and large municipalities in a number of places in humid East Texas have found this to be true. Reliable information as to the availability of surface-water supplies, and the distribution and quality of those supplies as to time and area served is essential to the work of the engineer in designing and operating water-supply systems that will fully develop the surface-water resources. The cities of Longview, Tyler, Beaumont, Corsicana, and other communities of east Texas, as well as towns in other parts of the State, have failed to obtain new industrial developments because their present water-supply systems were inadequate to meet the increased demands.

Hydrologists have divided the United States into five major moisture provinces—wet, humid, sub-humid, semi-arid, and arid. All of those except the wet province, occur in Texas. The arid province lies west of the Pecos River where the average annual rainfall ranges from 8 to 12 inches. The humid province includes east Texas where the average annual rainfall ranges from 40 to 55 inches. The semi-arid and sub-humid provinces lie between west and east Texas.

Surface runoff is primarily dependent upon rainfall. However, it is influenced considerably by evaporation, transpiration, surface topography, and the facilities for infiltration provided by surface soils and rocks. Soil types, vegetation, surface slopes and rainfall intensities, therefore, are all factors of nature that vary the relation between rainfall and runoff. Generally speaking, however, the relative average quantity of water in Texas streams follows the rainfall pattern across the State. Of the average annual rainfall of 30.84 inches for Texas, an average of only 2.9 inches runs off and appears as flow in the stream network. The residual rainfall is absorbed principally by evaporation and transpiration; and a small portion infiltrates into underground reservoirs, but it is eventually discharged into the streams or into the Gulf of Mexico.

Less than one inch of the average annual rainfall of extreme west Texas appears as flow in the streams. The yield increases progressively to a 15-inch average annual runoff along the Texas-Louisiana border where the average annual rainfall is 55 inches. There are large areas in Texas that contribute no surface water to streams of the respective regions. Those areas may, in some respects, be referred to as closed basins. The upper portions of the Brazos and the Colorado River watersheds, extend topographically across the high plains of the Texas Panhandle, yet the United States Geological Survey estimates that 11,800 square miles of the Colorado River watershed and 9,240 square miles of the Brazos River watershed contribute no surface flow to those streams.[1] Similar areas of lesser extent are found in the watersheds of the Canadian, the upper Red, and the Rio Grande. Rain that falls in those areas is held in small surface basins that have no surface outlets and the water is lost by evaporation, transpiration, or percolation into underground channels.

In contrast to the above-mentioned non-contributing areas, there may be found large springs that discharge into certain streams in the Rio Grande, Nueces, Guadalupe and Colorado River basins whose source of supply, or surface outcrop of the water-bearing formation, lies partly or completely outside of the watershed of the stream into which the spring discharges. A conspicuous example of this type is Comal Springs at New Braunfels. These springs discharge into the Comal River which has a surface drainage area of 94 square miles. The average discharge of this stream is 337 second-feet (225 million gallons per day), or a quantity of water sufficient to cover the 94 square mile drainage area with four feet of water. The average annual rainfall for the region is less than 30 inches. Therefore, it is obvious that a high percentage of the Comal River flow is derived from underground sources that outcrop outside of the Comal River watershed. Engineers and geologists of the Geological Survey, in cooperation with the Texas Board of Water Engineers, are now conducting a comprehensive survey of these and other large springs that discharge from the Edwards limestone.

Surface streams in some areas of Texas lose large quantities of water to underground formations. This is especially true of the stream network in the upper portion of the Nueces River basin. All of the normal and some of the flood flow of the West Nueces, the Nueces, the Frio, the Sabinal, and other smaller streams of the basin lying upstream from the Balcones fault zone is lost to underlying formations as the water flows across certain sections of the Balcones fault zone.

The City of Amarillo obtains part of its water supply from wells along the shore of the Amarillo City Lake. The wells extend into an underground formation that is partly recharged by seepage from the surface reservoir.

The flow of streams that are not primarily maintained by perennial flowing springs fluctuates directly with rainfall. As is generally known, the rainfall of Texas is very uncertain. All sections of the State are subject to prolonged drouths such as occurred in 1917-18, 1925, and 1939. At other times the State is subject to periods of intense rainfall that produce peak rates of flood flow of damaging proportion. 1900, 1913, 1921, 1935, and 1942 are some of the years of historical floods. The destructive floods that occurred during

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[1] Geological Survey Water-Supply Paper 958.

March and April 1945 in the Sulphur, Sabine, and the upper Neches River basins in northeast Texas are fresh in the minds of the people of those areas. Many of those people also will readily recall the severe crop losses during the drouth of 1939 when the Sulphur River near Darden remained dry for 71 days, and its flow was negligible for 335 days.

Although Texas streams yield large quantities of water that can be utilized to sustain future developments, it cannot be overemphasized that the occurrence of surface runoff, with few exceptions, is very irregular. Storage facilities must be provided to assure an ample supply for major water-use activities. The magnitude of the individual projects will depend entirely upon the total quantity of water that is known to be available.

## SURFACE RUNOFF

As a natural resource, water is not uniformly distributed. The surface supply varies greatly, and in this respect it resembles our soil, oil, and other minerals. However, water differs from other resources in that the supply is constantly being replenished, although the yield differs from year to year, and the distribution within a year varies from natural or man-made causes.

Since 1915, the Texas Board of Water Engineers and the United States Geological Survey have endeavored, so far as funds would permit, to establish stream-flow measurement stations at sites where it was anticipated that future developments would be made. In May 1945, 183 gaging stations were being maintained on the major rivers of Texas and their principal tributaries by the United States Geological Survey, in cooperation with the Corps of Engineers, U. S. Army, the Texas Board of Water Engineers, and other agencies. In addition to the 183 stream-measurement stations, gaging stations were maintained on 10 important canals, and at eight reservoirs and lakes gages were maintained for determination of storage contents. The discharge from two springs was measured occasionally. At several other springs continuous records of flow were obtained. Few records are available for streams having drainage areas of less than 100 square miles, and such data are badly needed.

The average annual runoff of Texas streams is 43 million acre-feet (14 trillion gallons)—a quantity sufficient to supply every man, woman, and child in the State with 6,100 gallons daily, or about 60 times the ordinary domestic requirement. About 35 million acre-feet of this runoff occurs as flood flow and is discharged into the Gulf of Mexico within a few days after the producing rains. Also, the annual yield varies widely from the average. In 1941 the total runoff was about 90 million acre-feet, and for 1925 it was less than 20 million acre-feet. The annual yield of individual streams has an even wider variation. Table No. 1 contains runoff data for some Texas streams.

Most streams of Texas originate within its borders. The Rio

Grande, the Red and the Sabine Rivers are boundary streams, and the Canadian River traverses the Panhandle region. The greater part of the population of Texas is not within the watersheds of these boundary or interstate streams; therefore, Texas must look primarily to the watersheds of the Neches, Trinity, San Jacinto, Brazos, Colorado, Guadalupe, and Nueces Rivers, and the smaller coastal streams for its surface water supply. All of these intrastate streams head in and traverse semi-arid or sub-humid sections, except the Neches River which lies entirely within the humid region of east Texas. Surface flows of these streams are erratic, but the average runoff is substantial and if properly controlled and utilized will provide water supplies for major industrial, hydro-electrical, and irrigation expansions throughout the State.

One-half of the average annual runoff from all Texas streams, or about 21,500,000 acre-feet, is carried by six of its smaller streams —the Sulphur, Sabine, Neches, and Trinity Rivers, Cypress Creek in northeast Texas, and San Jacinto River near Houston. The total drainage area of these east Texas streams is 46,000 square miles. The other streams in Texas, including the Rio Grande and Red River, drain seven times as large an area.

The Sabine River produces more water than any other stream in the State except Red River near Texarkana. The average annual runoff from the Sabine watershed is 6,000,000 acre-feet. The annual runoff, however, has ranged from 1,200,000 acre-feet to 12,500,000 acre-feet.

Streams in the eastern portion of the State are not subject to as rapid variations in flow as are those of other sections of Texas. Usually, they carry a considerable amount of flood runoff during the winter and spring months. Few floods occur during July to October, and the flow is generally low. It is during this period of low flow that unregulated east Texas streams are called upon to supply large quantities of water for rice irrigation, city water supply, and industrial uses. As a result, water shortages occur in the Beaumont-Port Arthur industrial area and other coastal regions of southeast Texas.

The Neches River may be considered by many as a dependable source of water supply. Yet, at Rockland for 15 months of 1924 and 1925, only two small floods occurred. The minimum flow during this period was 7 second-feet, an amount only sufficient to supply water for a city of about 45,000 people. A paper mill at Lufkin has a maximum need for about 15 second-feet, or 10,000,000 gallons of water daily. Therefore, the Neches River at Rockland would not supply a daily demand for one plant of this nature at all times unless flood waters are stored for use during periods of prolonged drouth. During this 15-month period the flow of the Neches River at Rockland remained below 10 second-feet for 39 days and below 75 second-feet for 6 months. The average discharge at this point over a 36-year period has been 2,378 second-feet.

The Brazos, Colorado, Guadalupe, Nueces, and Rio Grande basins are subject to long periods of low flow and short periods of flood flow, and therefore the runoff characteristics of these streams are quite different from those of streams in east Texas. From 70 to 90 percent of the total runoff occurs as flood flow extending over a few weeks of the year, except for streams such as the Devils and Guadalupe Rivers which derive a large portion of their flow from uniformly flowing springs. The Guadalupe River below New Braunfels is the most dependable stream in the State from the standpoint of a well-sustained low flow. Comal Springs and San Marcos Springs are the principal sources for its abundant supply of water. The combined flow of these springs supplies an average discharge of 464 second-feet to the Guadalupe River below its confluence with the San Marcos River. The combined minimum flow of these springs is 297 second-feet, thereby assuring the lower river of a sustained natural low flow of at least that much. This dependable flow is more than twice as much as may be relied upon in the lower reaches of the Neches, Trinity, or San Jacinto Rivers unless storage reservoirs are provided.

Little is known of surface runoff in the Davis Mountain region and the headwater tributaries of the Red, Colorado, and Brazos rivers in the high plains of the Panhandle, and of the Canadian River which crosses that region. Runoff records collected to date on streams originating in the high plains show the runoff to be low, the major portion of which is lost by infiltration before reaching the escarpment generally known as the "Cap Rock". Runoff of the Canadian River, which has cut into the high plains region and crosses it, is substantial, the average annual yield at Canadian, Tex. being 850,000 acre-feet for a six-year period ending in 1944. This is believed to be high, however, because the rainfall for 1941 and 1942 was much greater than the average.

The flow of all streams in 141 Texas counties drops to zero or useless quantities during drouth periods. The middle and lower reaches of the major rivers contain flows of usable but limited quantities during prolonged drouths. Some of the smaller streams that are fed by perennial springs, such as the South Concho, South Llano, Guadalupe, San Marcos, Frio, upper Nueces, Devils, and the lower Pecos River, maintain usable flows during drouths. The primary source of water for the lower Rio Grande valley during prolonged drouths comes from numerous large springs discharging from the Edwards limestone in the Langtry-Del Rio region. The combined minimum flow of these springs is about 600 second-feet.

Texans are becoming water conscious. They are learning that water is not always available. They are irrigating about 1,400,000 acres of land and have seen a single industrial demand exceed the domestic requirement of Houston, the largest city of Texas.

## MULTIPLE USES OF WATER

The limited supply of the unregulated flow of all Texas streams requires that flood waters be stored and conserved for multiple uses. The runoff is such that large volumes of flow with extreme rates of peak discharge occur in short periods of time. Drouths of from one to three years often reduce the flow to useless quantities. To conserve the flood runoff the engineer is confronted with the design of costly structures that are seldom utilized at capacity. The economical design of these structures is dependent upon the multiple uses of water. In many cases, power, irigation, municipal and industrial water supplies, and flood protection, will have to contribute to the construction and operation costs to justify the development. Such programs should be designed to function economically under full development of the major basins in which they are located.

TABLE 1

RUNOFF OF VARIOUS TEXAS STREAMS

Compiled from U. S. Geological Survey official records

| Stream | Contributing dr. area Sq. mi. | Years of record | Average Annual runoff Acre-feet* | Maximum yearly runoff Acre-feet | Minimum yearly runoff Acre-feet |
|---|---|---|---|---|---|
| **Canadian River Basin** | | | | | |
| Canadian River near Amarillo... | 19,830 | 1925,<br>1939–44 | 640,000 | 1,702,000 | 83,680 |
| **Red River Basin** | | | | | |
| Prairie Dog Town Fork Red River near Estelline.......... | 2,470 | 1925,<br>1939–44 | 119,500 | 298,900 | 24,170 |
| Red River near Colbert, Okla... | 38,330 | 1924–43 | 4,022,000 | 9,738,000 | 1,068,000 |
| Little Wichita River near Archer City...................... | 496 | 1933–44 | 79,640 | 187,800 | 14,010 |
| Cypress Creek near Jefferson.... | 848 | 1925–44 | 420,600 | 719,600 | 110,000 |
| **Sabine River Basin** | | | | | |
| Sabine River near Gladewater... | 2,846 | 1933–44 | 1,310,000 | 2,312,000 | 414,300 |
| Sabine River at Logansport, La.. | 4,858 | 1904-19,<br>1923–44 | 2,176,000 | 4,876,000 | 308,000 |
| Sabine River near Ruliff........ | 9,440 | 1925–44 | 5,977,000 | 12,460,000 | 1,240,000 |
| Big Sandy near Big Sandy...... | 235 | 1940–44 | 125,200 | 183,900 | 55,270 |
| **Neches River Basin** | | | | | |
| Neches River near Neches...... | 1,129 | 1940–44 | 571,200 | 907,800 | 109,000 |
| Neches River near Rockland.... | 3,539 | 1904–10,<br>1914–44 | 1,735,000 | 3,578,000 | 164,000 |
| Neches River at Evadale....... | 7,908 | 1905–06,<br>1924–44 | 4,566,000 | 9,206,000 | 720,000 |
| Mud Creek near Jacksonville.... | 382 | 1940–44 | 212,900 | 350,800 | 46,180 |
| Angelina River at Horger....... | 3,435 | 1929–44 | 2,166,000 | 4,183,000 | 612,000 |
| **Trinity River Basin** | | | | | |
| West Fork Trinity River at Fort Worth................. | 2,431 | 1921–44 | 333,000 | 1,182,000 | 46,400 |
| Trinity River at Dallas......... | 6,001 | 1904–44 | 1,089,000 | 3,389,000 | 100,600 |
| Trinity River near Oakwood.... | 12,840 | 1924–44 | 3,621,000 | 7,970,000 | 476,000 |
| Trinity River at Romayor...... | 17,190 | 1925–44 | 5,471,000 | 12,260,000 | 660,000 |
| Clear Fork Trinity River at Fort Worth.................... | 522 | 1925–44 | 69,940 | 212,200 | 11,700 |
| Chambers Creek near Corsicana. | 958 | 1940–44 | 522,700 | 763,900 | 260,100 |
| **San Jacinto River Basin** | | | | | |
| West Fork San Jacinto River near Conroe............... | 832 | 1925, 1927,<br>1940–44 | 407,600 | 1,173,000 | 26,600 |
| San Jacinto River near Huffman | 2,791 | 1937–44 | 1,372,000 | 4,518,000 | 416,800 |
| Buffalo Bayou at Houston...... | 368 | 1937–44 | 196,900 | 529,800 | 29,920 |
| **Brazos River Basin** | | | | | |
| Double Mt. Fk. Brazos River at Lubbock.................. | .......... | 1940–44 | 1,800 | 6,210 | 0 |
| Double Mt. Fk. Brazos River near Aspermont............ | 1,509 | 1925-34,<br>1940–44 | 136,100 | 380,100 | 30,140 |
| Brazos River near Glen Rose.... | 15,600 | 1924–44 | 1,256,000 | 2,785,000 | 245,000 |
| Brazos River at Richmond...... | 34,810 | 1904–05,<br>1923–44 | 5,827,000 | 16,120,000 | 1,240,000 |

TABLE 1—Continued

**RUNOFF OF VARIOUS TEXAS STREAMS**

Compiled from U. S. Geological Survey official records

| Stream | Contributing dr. area Sq. mi. | Years of record | Average Annual runoff Acre-feet* | Maximum yearly runoff Acre-feet | Minimum yearly runoff Acre-feet |
|---|---|---|---|---|---|
| Clear Fork Brazos River near Crystal Falls | 5,658 | 1929–44 | 373,600 | 1,040,000 | 63,800 |
| Little River at Cameron | 7,034 | 1918–44 | 1,455,000 | 4,285,000 | 129,000 |
| San Gabriel River at Georgetown | 415 | 1935–44 | 136,800 | 361,000 | 8,180 |
| **Colorado River Basin** | | | | | |
| Colorado River at Ballinger | 5,340 | 1908–44 | 299,700 | 789,200 | 54,590 |
| Colorado River near San Saba | 18,800 | 1917-19,<br>1921-22,<br>1931–44 | 1,356,000 | 2,790,000 | 314,000 |
| Colorado River at Austin | 26,360 | 1899–44 | 1,972,000 | 5,452,000 | 427,000 |
| Colorado River at Columbus | 29,040 | 1905-11,<br>1917–44 | 2,614,000 | 6,660,000 | 472,000 |
| Concho River near San Angelo | 4,217 | 1916–44 | 137,600 | 869,200 | 24,700 |
| San Saba River at San Saba | 3,046 | 1916–44 | 209,200 | 954,400 | 57,400 |
| Llano River near Junction | 1,762 | 1916–44 | 162,200 | 512,700 | 38,400 |
| **Guadalupe River Basin** | | | | | |
| Guadalupe River above Comal River at New Braunfels | 1,666 | 1929–44 | 297,600 | 630,600 | 58,360 |
| Guadalupe River at Victoria | 5,676 | 1917-18,<br>1921–44 | 1,141,000 | 3,092,000 | 437,000 |
| San Marcos at Ottine | 1,249 | 1916–43 | 330,000 | 751,100 | 110,000 |
| San Antonio River near Falls City | 2,067 | 1926–44 | 223,000 | 498,900 | 93,900 |
| **Nueces River Basin** | | | | | |
| Nueces River at Laguna | 764 | 1924–44 | 110,000 | 442,200 | 21,000 |
| Nueces River near Three Rivers | 15,600 | 1916-18,<br>1921–44 | 605,300 | 2,547,000 | 54,200 |
| Frio River at Concan | 485 | 1925–44 | 81,810 | 248,000 | 23,500 |
| Frio River near Derby | 3,493 | 1916–44 | 118,000 | 787,100 | 4,340 |
| **Rio Grande Basin** | | | | | |
| Rio Grande near El Paso | .......... | 1890-92,<br>1898–1913,<br>1915,<br>1916–32 | 774,700 | 2,400,000 | 24,500 |
| Rio Grande near Del Rio | .......... | 1901-13,<br>1926–32 | 3,084,000 | 6,082,000 | 1,530,000 |
| Rio Grande at Roma | .......... | 1901-02,<br>1904-12,<br>1924–35 | 4,450,000 | 8,254,000 | 2,720,000 |
| Pecos River near Comstock | .......... | 1901–35 | 410,500 | 1,060,000 | 158,000 |
| Devils River near Del Rio | 4,000 | 1901-13,<br>1925–30 | 388,100 | 609,000 | 221,000 |

*One acre-foot equals 325,851–gallons.

# Soil Resources of Texas

L. G. JONES and P. H. ROSAMOND

This war, as the first World War, has caused a rush toward land buying. Land involves a consideration of the soil itself, the climate, the topography, native vegetation, the proximity to market, and other factors of location.

About 17% of the land of the State is cropped. This means that there is still a vast area of land that may be used in an expanding postwar world demand which causes interest in comparing soils from various parts of the state.

Because soil may be low in plant nutrients it is not worthless. It may be of such physical condition, position and environment that it will respond to judicious soil-building practices and may outlast even the most fertile soils that are not well managed.

The soils of the State may be divided into 11 physiographic regions according to W. T. Carter. (1) Representative soil analyses indicate varying compositions according to Fraps. (2) From this standpoint some soils do not have much to recommend them, except good physical condition. Others have a high analysis but are difficult to work.

The best soils of the world have four different origins according to Charles Lawrence Baker; (3) the basaltic lava fields, Pleistocene scrapings, loess, and stream deposits. Texas soils are represented in three of these groups, and chemical analyses may give an indication of the fertility capacity. An old method of estimating durability of soils against cropping is to compare the plant removal to total elemental content.

One bale of cotton removes from the soil in pounds:

| | N | $P_2O_5$ | $K_2O$ |
|---|---|---|---|
| Lint | 1.5 | .5 | 24 |
| Seed | 31 | 12 | 11 |
| Stalks | 51 | 20 | 36 |
| Total | 81 | 33 | 71 |
| Soil Content | 2,560 | 2,420 | 24,400 |

An average productive blackland soil contains in total plant nutrients, 2560 pounds of nitrogen, 2420 pounds of phosphoric acid and 24,400 pounds of potash. If no erosion takes place this soil has a potentiality of about thirty nitrogen years, seventy phosphorus years and two hundred and forty potash years. Factors to reduce this mathematical estimate are accelerated sheet and gulley erosion, windstorms, and leaching. Factors that prolong this are geologic erosion, which figuratively pushes up the underlying material, green manuring, biotic factors such as nitrogen giving organisms, deposition from wind, water and animal carried materials and fertilizers.

Under favorable conditions the roots of leguminous plants such as the sweet clovers, bur clover, vetch, cowpeas, beans, lespedeza and white Dutch clover develop nodules which contain a special group of organisms. These are able to combine elemental nitrogen of the air into forms that ultimately may be used by the last plant. Carbohydrates of the legume is the source of energy for these bacteria. In our heavy blackland soils the plowing under of hubam clover has doubled the yield of cotton at the Blackland Experiment Station.

An average productive soil in the humid northeast shows the following comparison to a productive Texas soil.

| | Cornbelt | | Texas | |
|---|---|---|---|---|
| | Per Cent | Lbs. per acre furrow slice | Per Cent | Lbs. per acre furrow slice |
| Organic Matter | 4.00 | 80,000 | 2.50 | 50,000 |
| N | .20 | 4,000 | .128 | 2,560 |
| $P_2O_5$ | .15 | 3,000 | .121 | 2,420 |
| $K_2O$ | 2.00 | 40,000 | 1.22 | 24.400 |
| $CaO$ | .40 | 8,000 | 14.21 | 28,420 |
| $MgO$ | .30 | 6,000 | .82 | 16,400 |
| $SO_2$ | .15 | 3,000 | | |
| pH | 7.00 | | | |

The Texas soil appears to compare favorably except in nitrogen and organic matter. These differences are due to warmer climate where bacterial activity goes on twelve months a year.

How fast the organic matter decays, and therefore how much is needed to keep up the supply, depend partly on cultural practices, but even more on climate, the temperature, the rainfall, and the length of the growing season.

The tremendous influence of temperature on the rate of decay of organic matter has been often noted.

In the North, where the mean annual temperature is below 45 degrees the soil bacteria work for only a short season, and the breakdown of organic matter is relatively slow. Under such conditions, some of the organic matter tends to stay in the soil without breaking down completely, and the amount in the soil can be built up to a fairly high level and maintained without much difficulty.

In the belt where the mean annual temperature is above 45 degrees and below 55 degrees, the corn belt, soils normally contain a fair amount of organic matter, but it decays more rapidly and the percentage is lower on the average than in soils farther north.

Coming down the belt where the mean annual temperature averages 55 degrees to 65 degrees, we find still more rapid decomposition of organic matter and a still lower content in the soil. This is the Panhandle area of Texas.

Finally, in the deep South where organic matter decays rapidly and every month in the year, the normal content is exceedingly low. Any organic matter added to the soil quickly disappears, and it is difficult to keep up the supply.

So it is not possible to lay down any simple hard-and-fast rule as to how much organic matter a good soil should contain. It depends on where it is located.

The following is a comparison of a fresh granite and a residual clay: Area compared to a limestone and its residual clay.

Several attempts have been made to compare the chemical analysis of a soil with analysis of the unweathered rock mass beneath. The

| Constituents | Limestone Rock | Granite Rock | Limestone Rock | Limestone |
|---|---|---|---|---|
| $SiO_2$ | 7.41 | 60.69 | 57.57 | 45.31 |
| $R_2O_3$ | 2.89 | 25.95 | 28.37 | 38.73 |
| CaO | 28.29 | 4.44 | .51 | .00 |
| MgO | 18.17 | 1.06 | 1.21 | .40 |
| $K_2O$ | 1.08 | 4.25 | 4.91 | 1.10 |
| $Na_2O$ | .09 | 2.82 | .23 | .22 |
| $P_2O_5$ | .03 | .25 | .10 | .47 |
| Ignition loss | ............ | .62 | ............ | 13.75 |
| $CO_2$ | 41.57 | ............ | .38 | ............ |

assumption is made that the rock analyzed is of the same composition as that from which the soil was formed.

These two soils developed under humid-temperate conditions have been subjected to intense leaching. The one from limestone is a clay, very plastic and high in colloidal silicates. The one from granite is a deep red clay with numerous quartz grains present. Both soils have sustained severe losses in cations such as calcium, magnesium, sodium and potassium.

A Blackland soil of Central Texas representing roughly 11 million acres is given in a Houston Clay. It is compared with a Marshall silt loam of Iowa.

**Houston Clay**

| | N | $P_2O_5$ | $K_2O$ | CaO | MgO | pH |
|---|---|---|---|---|---|---|
| Houston Clay | .120 | .121 | 1.22 | 14.21 | .83 | 7.4 |
| Underlying Marl | ....... | .08 | 4.2 | 42.00 | 6.0 | 7.2 |
| Marshall Silt Loam | .22 | .23 | 2.40 | 1.38 | 1.10 | 6.9 |
| Underlying Marl | .10 | .15 | 2.17 | 1.59 | 1.33 | 7.0 |

The average yields are:

| | Corn, Bu. | Cotton, Bu. | Oats, Bu. | Hay, Ton |
|---|---|---|---|---|
| Houston clay | 18 | 187 | 28 | 1.2 |

From the analyses it is observed that this area of Texas although considered highly productive, still lacks something in phosphoric acid content. The difference in yields in favor of the Marshall is probably a combination of both soil and climate. Nitrogen is different also.

A virgin East Texas soil and a Georgia soil with the parent materials may be compared as follows:

| | N | $P_2O_5$ | $K_2O$ | CaO | MgO |
|---|---|---|---|---|---|
| Susquehanna fine sandy loam—Texas | .047 | .037 | .79 | .16 | .12 |
| Parent material of same | .043 | .036 | .88 | .21 | .13 |
| Susquehanna fine sandy loam—Georgia | .05 | .04 | .12 | .07 | ...... |
| Parent material—same | .01 | .10 | .16 | .09 | ...... |

| Yields in Cotton | Texas Soil Susquehanna fine sandy loam | Georgia Soil Susquehanna fine sandy loam |
|---|---|---|
| Untreated | 190 | 101 |
| 400 lbs. 4–8–4 | 291 | 280 |
| 400 lbs. 4–8–4 and green manure | 460 | 450 |

The state average for Texas is 182 lbs. in 1942 and Georgia is 240 lbs. This indicates both soils come from poor material. Both are low in plant nutrients being leached and "worn out". Both respond to fertilizer. The Georgia soil according to Hilgard (7) is one of the poorest soils of the U. S. in plant food and yet it makes good crops of both cotton and tobacco by the use of green manures and fertilizers.

A post oak soil, is compared to two Rio Grande Valley soils, a soil from New York state and one of the best Iowa soils.

| | N | $P_2O_5$ | $K_2O$ | CaO | MgO | pH |
|---|---|---|---|---|---|---|
| Lufkin fine sandy loam | .065 | .033 | .78 | .24 | .17 | 6.2 |
| In subsoil | .055 | .031 | .83 | .39 | .33 | 6.0 |
| Frio very fine sandy loam | .140 | .189 | 1.21 | 1.97 | .35 | 7.2 |
| In subsoil | .054 | .092 | 1.21 | .43 | .41 | 7.4 |
| Marshall silt | .10 | .23 | 2.17 | 1.38 | 1.10 | 6.8 |
| Subsoil | .11 | .15 | .91 | 1.59 | 1.33 | 6.9 |

The comparison here shows the subsoils of the post oak sod to be better in comparison with the surface soil than the more fertile soils.

For the Gulf Coast Prairie the Lake Charles Clay is compared with a sandy soil.

| | N | $P_2O_5$ | $K_2O$ | CaO | MgO | pH |
|---|---|---|---|---|---|---|
| Lake Charles Clay— | | | | | | |
| Surface | .118 | .036 | .84 | 1.17 | .46 | 6.5 |
| Subsoil | .073 | .030 | .73 | 1.32 | .55 | 6.4 |
| C. Horizon | .08 | .021 | .89 | 1.78 | .72 | 6.4 |
| Crowley Clay— | | | | | | |
| Surface | 1.64 | .041 | .53 | .36 | .17 | 5.8 |
| 36 inches deep | .088 | .077 | .14 | .41 | .33 | 5.7 |

All farm hay in Texas is .98 tons. This does not consider the analysis of the hay or the rice. Recent work by Fudge, Fraps and Brittingham (8) indicates that to have sufficient phosphorus in plants (and .33% $P_2O_5$ is the critical level) the soil must have an adequate supply. The following figures illustrate this:

| Lbs. $P_2O_5$ application | $P_2O_5$ per cent in plants | Forage yield per acre, Lbs. |
|---|---|---|
| None | .31 | 2600 |
| 20 | .40 | 3100 |
| 40 | .44 | 4000 |
| 80 | .59 | 5000 |
| 100 | .67 | 6900 |

The West Cross Timbers are among the poorest soils of Texas. Yet from this area comes the largest peanut shipments.

| | N | $P_2O_5$ | $K_2O$ | CaO | MgO | pH |
|---|---|---|---|---|---|---|
| Nimrod fine sand | .027 | .018 | .43 | .11 | .09 | 6.6 |
| Subsoil | .028 | .017 | .44 | .20 | .22 | 6.6 |
| Windthrost | .050 | .031 | .17 | .23 | .18 | 6.9 |
| Subsoil | .049 | .037 | .55 | .41 | .49 | 6.6 |

Yields of these soils are:

| | Peanuts | Corn | Cotton | Hay |
|---|---|---|---|---|
| | | | | Tons |
| Nimrod | 464 | 14.9 | 87 | .8 |
| Windthrost | 468 | 12.8 | 92 | .9 |

The Rolling Plains have a variety of soils. A Vernon fine sandy loam of Wichita County may be compared to the same series in Reno County, Kansas.

| | N | $P_2O_5$ | $K_2O$ | CaO | MgO |
|---|---|---|---|---|---|
| Surface—Kansas | .11 | .07 | 2.14 | .65 | ........ |
| Subsoil 20-40″—Kansas | .06 | .07 | 2.13 | 1.52 | ........ |
| Surface—Texas | .064 | .047 | 1.05 | 44 | .30 |
| Subsoil—Texas | .055 | .053 | 1.27 | 1.20 | .49 |

Crop yields are:

| | Wheat, Bu. | Corn, Bu. | Hay, Tons |
|---|---|---|---|
| Kansas | 12.3 | 14.2 | 1.43 |
| Texas | 8.4 | 13.8 | 1.1 |

It is seen that these soils represent an area fair in nitrogen, low in phosphorus and high in potash and calcium.

The high plains are probably aeolian in origin, medium and fine materials carried by wind from New Mexico and deposited on the Cretaceous Cap Rock during Tertiary and Quaternary times. Here we have one of the most fertile areas of Texas, a region of 21 million acres in which land now sells for $30 to $60 an acre. Given a fair break, with moisture, the land will produce 30 bushels of wheat, (av. 62) 30 bushels of oats, (16.2 av.) fourteen bushels of sorghum and ½ bale of cotton per acre. An added advantage is combine operation. Terry County once the "Corncrib of Texas" in some years made 30 bushels of corn per acre until the disastrous dusters of 1934-1935.

The following are two soil analyses, one sandy, the other clay, from the High Plains.

| | N | $P_2O_5$ | $K_2O$ | CaO | MgO | pH |
|---|---|---|---|---|---|---|
| Amarillo fine sandy loam | .109 | .066 | 1.46 | .66 | .45 | 7.3 |
| Subsoil | .070 | .069 | 1.83 | 1.41 | .63 | 7.3 |
| Richfield sandy clay loam | .118 | .086 | 1.64 | .82 | .60 | 7.1 |
| Subsoil | .079 | .082 | 1.74 | 1.72 | .77 | 7.2 |

Standard yields in Lubbock County are:

| Standard Yields | Cotton | Sorghum |
|---|---|---|
| Common | 154 | 8 bu. |
| Disease resistant or selected | 268 | 24 bu. |

On unirrigated land a six year average was 114 lbs. cotton per acre, while on a well irrigated area a 472 lb. cotton per acre average was obtained.

These soils are fair in nitrogen, low in phosphoric acid, and high in potash.

The Rio Grande Plain is an extensive area of 22 million acres. The soils are divided into the heavy clays, like the calcareous Victoria Clay, the Brown sandy loams, such as the Duval and Webb fine sandy loam in Frio and Atascosa County and the lighter blow sands such as the Nueces fine sand.

The table shows the heavy soils, Victoria clay to be good in nitrogen, phosphoric acid and potash. Yet this soil when cropped heavily responds to treatments of phosphate and nitrogen.

The sandy soils of the area illustrate the principle that the parent rock may lose heavily during weathering.

The effect of pasture treatment in a sub-humid country like Brooks County is observed on the Encino Division of the King Ranch.

| | Control No. Phosphate | Bone Meal Free Access | Fertilized Pasture |
|---|---|---|---|
| Number cows per section | 42 | 43 | 57 |
| Initial wt. of cow, av. lbs | 707 | 703 | 704 |
| Initial wt. of cow 1 year later | 752 | 1008 | 1036 |
| Initial wt. of cow 2 years later | 885 | 967 | 1027 |
| Initial wt. of cow 3 years later | 858 | 1046 | 1062 |
| % calf dropped first year | 90 | 93 | 100 |
| Final wt. calves prorated to all cows, lbs | 429 | 451 | 506 |
| Av. wt. calves, lbs | 499 | 523 | 544 |
| Av. blood phosphate MGM per 100 CC | 3.47 | 4.15 | 4.52 |

Phosphate appears to show up even in a sub-humid climate in the plant and annual.

### Rio Grande Plain

| | N | $P_2O_5$ | $K_2O$ | CaO | MgO | pH |
|---|---|---|---|---|---|---|
| Duval fine sandy soil—S. S. | .035 | .020 | 1.10 | .22 | .19 | 6.5 |
| Duval fine—Subsoil........ | .05 | .041 | 1.20 | .35 | .32 | 6.7 |
| Greensand—Bexar Co...... | ...... | 3.0 | 2.0 | 1.40 | .42 | ...... |
| Victoria Clay.............. | .135 | .133 | 2.15 | 1.28 | .71 | 7.5 |
| Victoria Clay—Subsoil..... | .076 | .112 | 2.40 | 3.71 | .79 | 7.6 |
| Nueces.................... | .031 | .026 | .99 | .10 | .18 | 6.9 |

This illustrates the contrast between the parent rock and the soil. (The Nueces sandy soils are poor in phosphate.)

From the foregoing we can make the following rough estimates:

| | N | $P_2O_5$ | $K_2O$ | CaO | MgO | pH |
|---|---|---|---|---|---|---|
| Highly productive heavy soils—52 million acres. Moderate Productivity... | .128 | .121 | 1.22 | 4.91 | .65 | 6.9–7 |
| Sandy soils—40 million acres | .065 | .033 | .78 | .24 | .17 | 6.2 |
| Low Productivity 13 million acres.................... | .02 | .01 | 0.3 | .15 | .09 | 5.5 |
| Non-Arable stony or shallow | .03 | tol. .01 | -.12 4 | to 1 | | |
| | | | | .1–30 | .01–6 | 5–7.5 |
| 30 mi. ac. Arid to semi-arid smooth—13 mi. ac.capable of being irrigated........ | .140 | .189 | 1.21 | 1.97 | .35 | 7.2 |
| Semi-arid, stony, gravelly... | .354 | .103 | .93 | 19.43 | .62 | 3.5 |

This state has its share of fertile soil. We have over 100 million acres of soils where good moisture conditions prevail. There are certain areas which because of steep slope erosion hazard, low fertility, and other unfavorable conditions, may not be recommended for use except in those cases where correct practices, reclamation development, proper fertilization and other measures for developing and maintaining the best use of the soils may be carried out.

It may be concluded that Texas soils in comparison with soils of other states, are well supplied with potash, calcium and other bases, but for continued productivity they need attention to nitrogen, organic matter and phosphorus.

We have soils that rank among the best anywhere. There are others which could hardly have a lower plant food content. The real test of a comparison is in the cropping record over a period of years. Under this test the soil resources may be accounted as above average.

| | N | $P_2O_5$ | $K_2O$ | CaO | MgO | pH |
|---|---|---|---|---|---|---|
| Houston Clay | | | | | | |
| Surface | .120 | .121 | 1.22 | 14.21 | .83 | 7.4 |
| Marl | ...... | .080 | 4.20 | 42.00 | 6.10 | 7.2 |
| Marshall Silt Loam | | | | | | |
| Surface | .22 | .23 | 2.40 | 1.38 | 1.10 | 6.9 |
| 3 ft. deep | .10 | .15 | 2.17 | 1.59 | 1.33 | 7.0 |

| Yields | Corn, bu. | Cotton, bu. | Oats, bu. | Hay, tons |
|---|---|---|---|---|
| Houston clay | 18 | 187 | 28 | 1.2 |
| Marshall silt loam | 54 | .......... | 32 | 1.44 |

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## A Few Scientific Conceptions of Our Ground-Water Resources[1]

WILLIAM L. BROADHURST[2]
Austin, Texas, November 1945

Until comparatively recent times the origin and the modes of occurrence of ground water have been clothed with mystery. The following statements by Meinzer[3] tell of ancient concepts of the origin of springs.

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[1] Published by permission of the director of the Geological Survey, United States Department of the Interior.

[2] Associate Geologist, Division of Ground Water, Geological Survey, United States Department of the Interior.

[3] Meinzer, O. E., The history and development of ground-water hydrology: Journal of the Washington Academy of Science, vol. 24, January 15, 1934.

> From the dawn of history nearly to the present, the source of water that flowed from springs constituted a puzzling problem that was a subject of much speculation and controversy. Prior to the latter part of the 17th century it was generally assumed that the water discharged from springs could not be derived from the precipitation, first, because the rainfall was believed to be inadequate in quantity, and second, because the earth was believed to be too impervious to permit penetration of the rain water far below the surface. With these two erroneous assumptions lightly accepted, the philosophers devoted their thoughts to devising ingeneous hypotheses to account in some other way for the spring and stream water. Two main hypotheses were developed: one to the effect that sea water was conducted through subterranean channels below the mountains and was then mysteriously purified and raised to the springs; the other to the effect that in the cold dark caverns under the mountains the subterranean atmosphere and perhaps the earth itself were condensed into the moisture that fed the springs.

The theory now universally accepted by hydrologists is that ground water for the most part is derived from rain and snow by infiltration from the surface.

Geology relates to the rock formations that make up the great and intricate system of natural waterworks, the functioning of which forms an essential part of the subject of ground-water hydrology. Therefore, although earnest attempts were made to give useful information as to the water-bearing properties of different rocks, the subject could not be far developed until the fundamental principles of geology were established near the close of the 18th century.

In the United States not much systematic ground-water work was done before 1873. However, almost 100 years ago, in 1856, George H. Shumard made a brief report on artesian conditions near Amarillo, Texas, for the Pacific Railway survey. From 1900 to the present time there has been increased activity in the study of ground water, with more specialized workers than in any earlier period. Most of the work has been done by the staff of the United States Geological Survey, and hundreds of papers that relate primarily to ground water have been published.

The cooperative investigation of the ground-water resources in Texas by the State Board of Water Engineers and the Federal Geological Survey was started in September 1929. It is made possible by appropriations by the State Legislature and several local agencies, the State and local allocations being matched by an equal amount of Federal funds. It was Mr. John Norris, chairman of the Board from 1921 until 1936, whose vision and enterprise got the cooperative work started, and the harmony with which the State and Federal agencies have worked through the years has been maintained under the leadership of Mr. C. S. Clark, who has been chairman of the Board since 1936. From the beginning the technical work has been done under the direct supervision of W. N. White, principal hydraulic engineer, and under the general supervision of O. E. Meinzer, chief of the division of ground water. During this period of only 16 years in which the cooperative investigation has been in progress, ground-water studies have been made in nearly every part of the State, and several hundred reports have been released in printed, mimeographed, or manuscript form, which, according to Mr. White, represent the largest volume of water-well data in the world. Nevertheless, about 40 percent of the State remains untouched and much more research is needed.

In Water-Supply Paper 638-C, Meinzer[4] discusses the principal methods of ground-water study under two major headings: rock formations as reservoirs and rock formations as conduits. He explains that some water-bearing formations function chiefly as reservoirs, others chiefly as conduits, but all of them have some of the properties of both. In attempting to solve the quantitative problems of ground-water supplies these two functions of rock formations must be recognized and differentiated. Quantitative methods based on the reservoir conception are applicable chiefly, though not exclusively, to formations or parts of formations that have water tables, and involve measurements of the rate of recharge to or discharge from the aquifer and determinations of changes in storage. Methods based on conduit conception are applicable most largely to artesian formations, in which the water moves laterally considerable distances from the intake to the discharge area. They involve determinations of the transmissibility of the formation by means of laboratory tests or tests made in the field by pumping a well and observing the effects on the water levels in the well itself and in selected nearby observation wells both during the pumping and after the pumps are shut off. Regardless of its size or the rate of recharge at the intake, an underground reservoir may be practically valueless as a source of supply if the transmission capacity of the water-bearing beds is low. The situation is analogous to that in which the source of supply for a project is a distant stream. No matter how large the stream, the maximum amount of water that can be used by the project is determined by the capacity of the aqueduct that brings the water to the project.

Under conditions of nature, the underground reservoirs nearly everywhere are in a state of equilibrium in which, over a long period of years, ground-water recharge is approximately balanced by discharge. It follows that, in order to avoid depletion, withdrawals made by man must be compensated by an increase in ground-water recharge or by a decrease in the natural discharge. Increase in the recharge may result from withdrawals through wells if the cone of depression produced by pumping reaches the outcrop of the aquifer and lowers the water table so that recharge which otherwise would be rejected is absorbed. Decrease in the natural discharge results if a part of the water is intercepted by wells which otherwise would pass on to the natural outlets.

The rate of flow of water in an aquifer has been found to be directly proportional to the hydraulic gradient. In 1856, Darcy, inspector general for the Paris water works, verified this law as being applicable to water flowing in small pipes or percolating through capillary interstices of sand or other porous media, and it is now known as Darcy's law. In 1923 a hydrological laboratory was established in the Washington office of the Geological Survey; and, with apparatus designed by Meinzer, tests have been made on many thousands of samples from well cuttings and from the outcrops of water-bearing beds by passing water through the samples under varying heads. In these experiments, Darcy's law was found to hold under gradients as low as a few inches to the mile.

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[4] Meinzer, O. E., Outline of methods for estimating ground-water supplies: U. S. Geol. Survey Water-Supply Paper 638-C, 1932.

An important factor to keep in mind is that artesian aquifers in unconsolidated rocks are elastic. The sand grains and the beds of silt and clay associated with them are alternately compressed and expanded as the artesian pressures increase and decrease. Hence, as a result of withdrawals through wells, the artesian pressures decrease and water is released from storage. The amount released per unit volume of the aquifer per foot of decline in artesian pressure is very small but in the aggregate may represent a large quantity of water, because the cone of depression produced by ground-water withdrawals from an artesian aquifer expands rapidly and causes a drop in artesian head over large areas. Therefore, the total withdrawals from storage in a heavily pumped artesian aquifer may be very large, even though there may be no unwatering of the sands at the well field or decline of the water table at the outcrop.

The effects of withdrawals from an area in which water-table conditions exist are somewhat in contrast. In such areas the water-bearing beds become unwatered as the water table is lowered by pumping, and relatively large quantities of water are released per unit volume of the aquifer per foot of decline of the water table. The volume of water thereby released from storage may be 25 percent or more of the volume of the material unwatered. This ratio between the volume of water released from storage by the unwatering and the volume of material unwatered is expressed as the effective porosity, or specific yield, of the material. Because of the large amount of water released from storage in water-table areas, the cone of depression produced by pumping spreads rather slowly and the effects of pumping large quantities of water may not be appreciable for several years at a distance of only a few miles from the center of pumping.

The major part of the ground water of Texas occurs in comparatively few aquifers. The most important, from youngest to oldest, are the outwash (bolson) deposits, the sands in the Beaumont clay, the sands of the Lissie formation, the Willis and Goliad sands, the Ogallala formation, the Carrizo sand, sands of the Wilcox group, the Woodbine sand, the Edwards limestone, and the Travis Peak formation (commonly called the Trinity sands). With the exception of the Edwards limestone, all the important water-bearing formations consist chiefly of sand, sandstone, or sand and gravel; and with the exceptions of the outwash (bolson) deposits in the Pecos area and the Ogallala formation in the High Plains, they all occur under artesian conditions in the areas of heavy withdrawals.

These natural underground reservoirs have a very large capacity compared with the capacity of man-made surface reservoirs. The underground reservoirs usually respond to the effects of drought much more slowly than the surface reservoirs, and water supplies derived from them, especially from the larger and deeper reservoirs, usually are secure during a succession of dry years. However, if the water withdrawn from either underground or surface reservoirs is taken from storage without being replaced, the supply will eventually fail. If the water is obtained from shallow deposits or from deeper sands that are very thin, the wells may actually become dry or nearly dry. In most places, however, the failure will be economic and will come long before the supply is entirely exhausted.

Development of the ground-water resources of Texas has progressed at a rapidly increasing rate during the last ten years, chiefly to meet the demands for irrigation and industrial expansion. For example, irrigation with water from wells in the High Plains increased from about 35,000 acres in 1934 to about 450,000 acres in 1944.

A few of the areas in which ground-water resources are being utilized on a large scale and the approximate average daily demands during 1944, are as follows: El Paso-Juarez area, 25 million gallons; Southern High Plains, 340 million gallons; San Antonio area, 100 million gallons; Winter Garden district, 40 million gallons; and the Houston-Galveston region, more than 200 million gallons.

Industrial development on a large scale in many parts of Texas is just ahead. The plants that are already established and the potential new industries require large quantities of water, which must be of the proper chemical character. Ground water is desired for many of them because of the relative constancy in the chemical character and temperature of the water.

The people of Texas deserve to reap the full benefits from industrial, economic, and social development, which justify intensive scientific investigation of the State's important underground resource—ground water. The most urgent problems in the study of ground-water resources at present are those relating to the rate at which rock formations will yield water to wells in specified areas—not for a day, a month, or a year, but perennially.

## The Oil and Gas Resources of Texas, Their Geographical Distribution within the State with Brief Comments on the Importance of these Resources in the Economic Life of the Citizenship of the State as a Whole

OLIN CULBERSON, Chairman,
Railroad Commission of Texas

The first recorded use of oil in America by white men occurred in the year 1543 near Sabine Pass in East Texas. It is said that survivors of the De Soto Expedition, as they made their way along the Gulf Coast of Texas in that year, were forced ashore by storm and that during their inland stay near Sabine Pass that they caulked their boats with pitch. This pitch product which they used for caulking their boats was in all probability the residue of oil from surface seeps in that area. There seems to be no doubt however, that long before this time the Indians knew about oil seeps in the state and that oil was used by some Indian tribes for various purposes including its use by their medicine men. It may truly be said, however, that the modern petroleum industry of Texas had its beginning at Oil Springs near Nacogdoches, Texas, where the first oil well in the state was completed in the year 1866. It was not of course, until the discovery of oil at Corsicana in 1894, at Spindle Top in 1901, and in later years at Desdemona, Ranger, Burkburnett, Wink, Mexia, and many others, and in still later years the tapping of the great East Texas Field reservoir, and the completion of the Strake discovery at Conroe that the people of Texas and of the nation as a whole became generally aware of the fact that Texas was blessed with oil and gas resources to an extent far greater than was known to exist anywhere else in the nation.

The oil and gas resources of the state and a resume of the influence that these reserves have had in its development is too large a subject to be covered comprehensively here. We may, however, touch briefly on the subject by comparing the present with the past in connection with the development of these resources and thus obtain some idea of the effect which their presence in this state has had and is now having in our economic life.

When one concerns himself with the problem of making a reasonable determination of the oil and gas reserves contained within subterranean reservoirs, such person, by the very nature of the information which he needs with respect to such reservoirs, sets himself to a task of some magnitude. This statement is true with regard to any individual reservoir. When we consider the multitudinous number of such subterranean reservoirs within this state and when we consider the further fact that the part of the reservoir that is cut by the drill bit is such a small fraction of the total reservoir volume, even under what we might term a dense drilling pattern, we cannot but realize that reserve figures on oil and gas are, at their best, estimates only. To be sure some of such estimates may be fairly accurate, but they are none the less still estimates, because we are not able to make our reservoir analyses on any substantial portion of the reservoir space, nor are we ever able to do more than approximate the total volume of such reservoir. Because of these things we, therefore, find various figures used here and there as reflecting the oil and gas reserves of Texas and of the nation. It is usually found, however, that the variance as between such figures is well within the limits of the accuracy of their determination and that with respect to the composite total the percentage of variance is small.

Texas may be roughly grouped into seven general geological provinces for the purpose of geographically locating the oil and gas reserves in the state. These provinces are as follows:

| Geological Province | Geographical Location |
|---|---|
| Permian Basin | West Texas |
| Amarillo Arch | Texas Panhandle |
| Bend Arch | North Central Texas |
| Balcones Fault Zone | East Central Texas |
| Tyler Basin | East Texas |
| Gulf Coast Salt Dome Area | From E. line of Jackson County along Gulf Coast to Louisiana Line. |
| Southwest Texas Area | From E. line of Jackson County along Gulf Coast to Rio Grande River. |

Not all of the counties lying within the geological provinces above named have proven oil and gas deposits. Suffice it to say however, that as of this date 177 of the 254 counties within the state have either produced or are now producing either oil or gas or both.

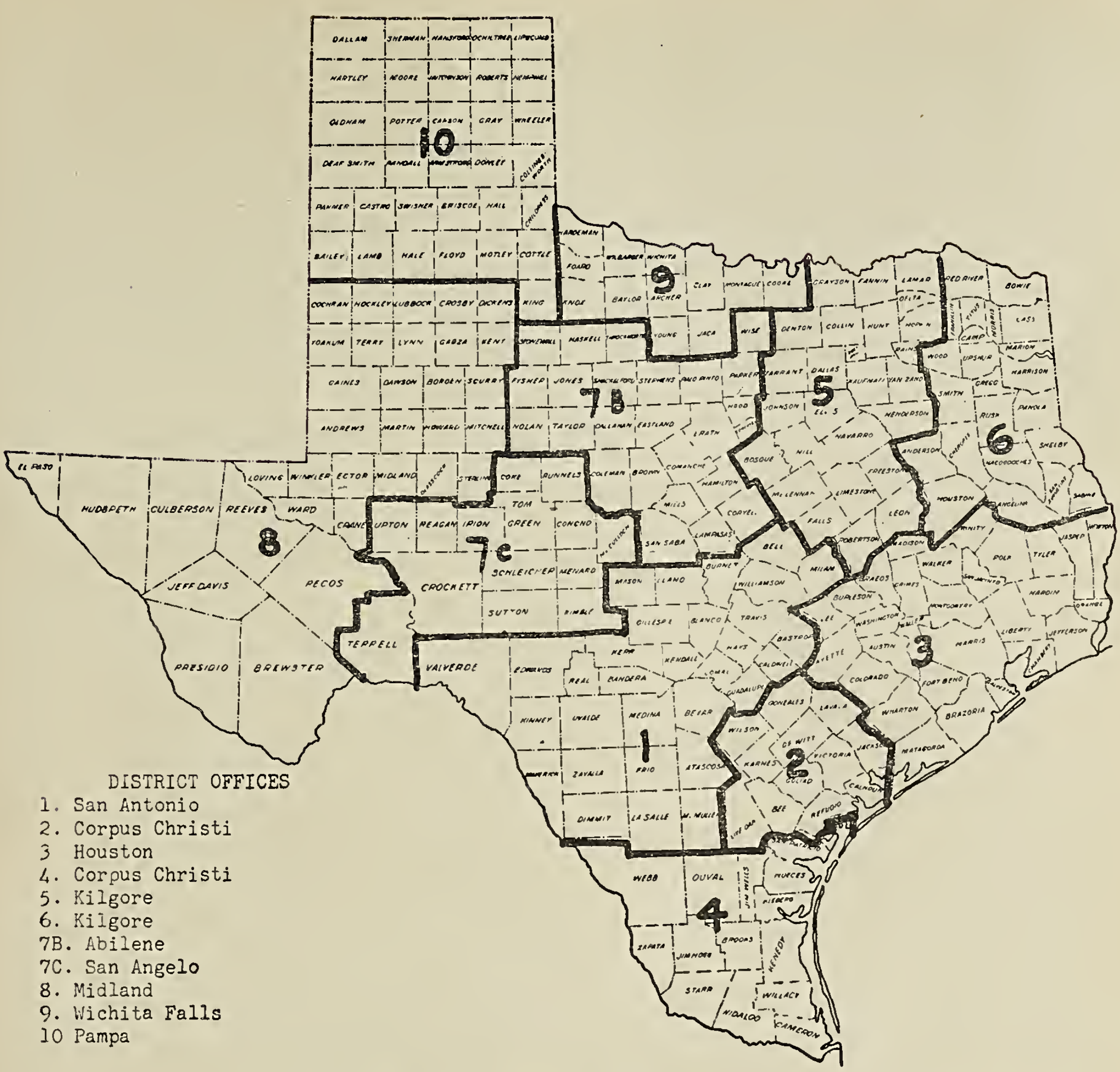
A study of the various estimates of the oil reserves in the United States which have been made from time to time in the past shows that the portion thereof that is contained within Texas has shown a constant increase in its relationship to the total of such figures for the nation as a whole. The following tables showing estimates of known oil reserves by states indicate that Texas had, as of January 1, 1925, a known oil reserve approximating 13.8% of the then known oil reserve for the nation; that by January 1, 1935, 45.2% of the nation's known oil reserve was in Texas, and that by January 1, 1945, this figure had increased to where approximately 56% of the known remaining oil reserves in the nation are within the confines of this state.

(See following table showing estimates of known oil reserves of the United States.)

**Estimates of Known Oil Reserves of the United States**

| | Reserves (Barrels) | Per Cent of U. S. Reserves |
|---|---|---|
| **January 1, 1925** | | |
| Texas | 732,000,000 | 13.8 |
| California | 2,140,000,000 | 40.2 |
| Oklahoma | 1,040,000,000 | 19.5 |
| Louisiana | 134,000,000 | 2.5 |
| Kansas | 315,000,000 | 5.9 |
| New Mexico | 13,000,000 | 0.2 |
| Arkansas | 122,000,000 | 2.3 |
| Rocky Mountain Area | 355,000,000 | 6.7 |
| Midwest and East | 472,000,000 | 8.9 |
| Total | 5,323,000,000 | 100.0 |
| (Source—American Petroleum Inst.) | | |
| **January 1, 1935** | | |
| Texas | 5,500,000,000 | 45.2 |
| California | 3,500,000,000 | 28.7 |
| Oklahoma | 1,200,000,000 | 9.8 |
| Louisiana | 375,000,000 | 3.1 |
| Kansas | 400,000,000 | 3.3 |
| New Mexico | 350,000,000 | 2.9 |
| Arkansas | 75,000,000 | 0.6 |
| Rocky Mountain Area | 322,000,000 | 2.6 |
| Midwest and East | 455,000,000 | 3.8 |
| Total | 12,177,000,000 | 100.0 |
| (Source—American Petroleum Inst.) | | |
| **January 1, 1945** | | |
| Texas | 11,520,227,000 | 56.2 |
| California | 3,279,387,000 | 16.0 |
| Oklahoma | 1,138,139,000 | 5.5 |
| Louisiana | 1,246,543,000 | 6.1 |
| Kansas | 751,273,000 | 3.7 |
| New Mexico | 541,926,000 | 2.6 |
| Arkansas | 326,768,000 | 1.6 |
| All Others | 1,710,476,000 | 8.3 |
| Total | 20,514,739,000 | 100.0 |
| (Source—Oil & Gas Journal) | | |

The following table shows a geographical break-down of the indicated oil reserves for the State of Texas as of January 1, 1945. The break-down of this figure has been made according to Railroad Commission Districts within the State which have been set up and which are used by the Commission in its administration of the oil and gas laws. Those not familiar with the area embraced within the respective Commission Districts may refer to the accompanying map of the state which map has been so marked as to identify each



respective district. This break-down of the total oil reserve figure for the state is as follows:

| Railroad Commission District | | Oil Reserves (Barrels) |
|---|---|---:|
| 1 | Southwest Texas | 74,145,000 |
| 2 | Southwest Texas | 600,868,000 |
| 3 | Gulf Coast | 2,652,686,000 |
| 4 | Southwest Texas | 849,705,000 |
| 5 | East Central Texas | 333,140,000 |
| 6 | East Texas | 2,928,470,000 |
| 7B | West Central Texas | 103,730,000 |
| 7C | West Central Texas | 100,780,000 |
| 8 | West Texas | 2,857,700,000 |
| 9 | North Texas | 498,303,000 |
| 10 | Panhandle | 520,700,000 |
| | Total | 11,520,227,000 |

The importance of gas reserves to the state is seemingly just beginning to be realized and for this reason, perhaps, we do not find estimates of gas reserves over the period that estimates have been made as to oil reserves. Where we find current estimates of available gas reserves in the state, we find that these estimates vary more widely than do the estimates that have been made with regard to the oil reserves. In the following table is set out, by Railroad Commission Districts as previously explained, a conservative estimate of gas reserves within the state including gas recoverable from reservoirs which produce both crude oil and gas. It will be noted that this table shows an estimated gas reserve for the state as of January 1, 1945, of 64,153,782 trillion cubic feet distributed geographically in the state as follows:

| Railroad Commission District | Gas Reserves (In Millions of Cubic Feet) |
|---|---|
| 1—Southwest Texas | 80,241 |
| 2—Southwest Texas | 2,366,873 |
| 3—Gulf Coast | 19,210,302 |
| 4—Southwest Texas | 9,110,065 |
| 5 & 6—East and East Central Texas | 6,791,242 |
| 7B & 7C—West Central Texas | 209,814 |
| 8—West Texas | 2,642,055 |
| 9—North Texas | 62,274 |
| 10—Panhandle | 22,680,916 |
| Total | 64,153,782 |

The greatest of all known gas fields is the Panhandle Field of Texas, which has at present a proven productive area of approximately 1,500,000 surface acres and an estimated gas reserve which approximates ¼ of the national total. Next in line, geographically speaking, is the Gulf Coast District of Texas which has approximately 30% of the state's gas reserve. The two largest fields in this area, from a reserve standpoint, are the Katy Field with a reserve estimate of 7½ trillion cubic feet and the Old Ocean Field with a reserve estimate of somewhere between 3½ and 5 trillion cubic feet. The remaining estimated gas reserve for the state is principally in the Southwest Texas and East Texas areas with the Carthage Field in Panola County being one of the more recent newer developments in East Texas. Nearly 39% of all the gas produced in the United States is produced in Texas.

Obviously, we can only here touch on a few of the outstanding examples of how the presence of these reserves in the state has affected its development and how current production and utilization of such reserves are tied in with our state economy. One of the important effects of the presence of these reserves within the confines of the state is reflected by population statistics. If we study population statistics with regard to counties under which substantial portions of these oil and gas reserves lie, we find that there is recorded in each case a substantial increase in population. A survey of 31 representative counties in which oil and gas have been discovered, over the preceding 25-year period, shows that the population of those counties has increased in this time an average of 112%; this as compared with an increase in the population of the state as a whole of some 38% for the same period. In some of these counties the increase in population which may be directly attributable to the discovery of oil and gas therein, ranges as high as 7400%. Similar changes in population because of the influence of the oil and gas industry, are recorded by various cities even though such cities are sometimes far removed from the nearest known oil and gas reserves. Fort Worth, for instance, is far removed from the West Texas or Permian Basin Area, but we find that many oil companies maintain their company headquarters to govern their West Texas operations in this city, and in general, Fort Worth is recognized as the center of the West Texas oil industry. It is said that 40% of the people living in Fort Worth are directly dependent upon the petroleum industry as a source of livelihood. The same picture is true with respect to Dallas. Although Dallas is far removed from the East Texas Oil Field it, nevertheless, holds an important position as a center for operating headquarters for many oil companies, both large and small. Corpus Christi has shown an increase in population from approximately 10,000 people in 1920 to 100,000 in 1943 and Houston has grown from a city of approximately 138,000 population in 1920 to something in excess of ½ million in 1943.

It is said that employees of the Texas petroleum industry, together with their families, comprise well over 10% of the state's population of some 6½ million people, and that Texas petroleum industry's workers and their families comprised 1/6 of the population of the State prior to the beginning of the last war. It is estimated that this industry in Texas employed some 190,000 people in 1943, and that the payroll or amount paid for wages and salaries to these employees totalled some 332 million dollars during that year.

To try to point out here the effect that the presence of our oil and gas reserves in the state has on the daily life of the average citizen of the state, is to go far beyond the scope of this paper. Certainly, it would be hard for any of us to visualize conditions as they might have been had not their presence in this state heretofore been determined. We can in this brief survey point out, however, some general matters which should not be overlooked in touching on this subject. For instance, there is in excess of 49 million acres of land within the state that has been leased for oil and gas, and the lease rentals and bonuses paid to lessors during 1943 approximated 70 million dollars. Statistics show that the acreage leased for oil and gas development in the state in 1919 approximated 7,500,000 acres and that during that year the lease rentals and bonuses paid to the lessors of this property approximated 8 million dollars. Thus, it is seen that one of the effects of the presence of oil and gas reserves within the state has been to cause a distribution of many millions of dollars to Texas' landowners in the form of lease rentals and bonuses. Statistics also show that royalty payments to owners of oil and gas royalty in the year 1919 was in excess of 20 million dollars and that this had increased to where, in 1943, it approximated 96 million dollars. Of course, all of the owners of royalties under oil and gas producing properties within the state do not live therein, but it is safe to assume that a major portion of the payments made on oil and gas royalty within the state is distributed to parties living here.

One important effect that the petroleum industry has had on the State of Texas, and one which should not be overlooked, is the part which it has contributed toward state and local taxes. Many producing oil states levy a severance tax on oil and gas in lieu of ad valorem taxes, but this is not done in Texas. In Texas real estate property is subject to tax levies by any number of local taxing agencies, all of which have the power to levy and collect ad valorem taxes from the same properties. The Texas Mid-Continent Oil and Gas Association is authority for the statement that the petroleum industry in the state during 1943, paid in a total of $97,659,064 for state and local ad valorem taxes, gross receipt taxes, franchise taxes, and other taxes; whereas, the total paid in as taxes, under these various classifications, from all other sources within the state for that year was $157,632,192. As an example of what this source of income has meant, we have only to remember conditions in the area of what now constitutes the East Texas Oil Field prior to discovery of oil in that locality and compare it with the conditions there today. We now find paved roads running in all directions throughout the field with many school districts having been consolidated and with up-to-date school buildings having been constructed on a wide scale. The effect of this source of revenue has not perhaps been as pronounced in some areas as it has in others, but there is no denying the fact that the oil and gas industry in the state has contributed much in the way of taxes to the building up of our state school and highway systems.

In 80 representative counties of the state ad valorem taxes on petroleum properties are shown to comprise approximately 54% of all levies on all taxable properties in those counties. The tax rolls filed with the State Comptroller show that in these 80 counties the ad valorem taxes for 1943 that were levied on properties of the oil and gas industry in those counties aggregated approximately $18,000,000 out of approximately 33½ million dollars ad valorem taxes levied on all taxable property in those counties that year. These sums do not include ad valorem taxes levied on properties by independent taxing districts such as independent school, road, water, navigation, city, levee districts, irrigation, drainage, and other agencies which do levy and collect taxes on such properties. Nearly 46% of all revenues shown as receipts in the Omnibus Tax Clearance Fund for the fiscal year 1943 were derived from taxes collected from the petroleum industry in the state. Collections from crude oil, natural and casinghead gas, carbon black, and oil well servicing totalled some $28,363,000.00 for that period as against total receipts from all sources for the same period of approximately $61,904,000.00. Nearly $15,000,000.00 of this fund went to the public schools, and over $44,000,000.00 therefrom was allocated to old age pensions, institutions for the blind, dependent children, and the state's General Revenue Fund. Gross receipts taxes collected for oil and gas aggregated more than $32,000,000.00 in 1943 and were substantially higher in 1944 because of the higher rates of production that prevailed. One-fourth of the revenue from the gross receipts tax goes to the support of the state's public schools and the remainder is used for old age assistance, aid to the blind, aid to dependent children, with a portion going to defray the expenses of state regulation and the remainder to the General Revenue Fund.

Although the exploratory drilling campaign in the state has gone steadily forward, statistics show that operators are now drilling from 9 to 10 holes averaging more than 5,000 feet in depth in order to bring in one producing discovery of any reserve magnitude. The risks attendant to the search for oil in Texas have been multiplied in recent years by the diminishing rate at which new sources of production are being found. In the two years of 1938-39 the average quantity of oil found per foot of exploratory hole drilled was approximately 59 barrels. In 1941-42-43 more exploratory footage was drilled than was drilled in 1938-39, but the oil found per foot dropped to 20 barrels. Costs of exploratory wells have also shown a gradual increase in the last 10-year period. In 1935 the average cost of exploratory wells approximated $30,000.00 per well, whereas in 1943 the average cost of such well approximated $50,000.00. It appears probable therefore, that there will be no additional substantial reserves of either oil or gas uncovered within the state at producing depths less than 6000 feet to 8000 feet.

What there is left to be discovered in the way of oil and gas reserves in the state is something that only the passage of time will tell. The trend seems to indicate however, that as we delve deeper into the earth in our search for oil that what we more often encounter is high pressure gas accompanied by less and less crude oil, as such. I would say that this statement is more especially true with regard to the deeper exploratory wells that have been completed as producers in the Upper and Lower Gulf Coast areas. Actually it has been only within the last few years that exploratory wells to depths sufficient to penetrate the Devonian, Silurian, and Ellenberger formations have been drilled in substantial numbers in the Permian Basin area. Within these last few years, however, several sources of Ellenberger production in this area have been tapped with some completions having also been made in the Devonian section. Judging from completions made therein the Silurian section has been disappointing.

At our present rates of withdrawing our oil reserves and the probable rate that we will be required to draw on them to meet even our peacetime needs within the next few years, it is obvious that our present known oil reserves in the state will be used up in the relatively near future. Since the uses to which the constituents of natural gas may be put, are coming into being so rapidly and the profligate dedication to inferior uses and wasteful utilization of this valuable natural resource it would probably be unwise to assume that our present known gas reserves will last more than 40 to 50 years. Maybe we are entering an era where atomic or some other form of energy will be used to supplant a major portion of the energy now being derived from the use of our oil and gas resources. Who knows?

# Salt and Sulphur Resources of Texas

Z. W. BARTLETT

November 9, 1945

## SALT RESOURCES OF TEXAS

Salt[1] is a cheap but indispensable mineral. Ancient history records its use for food and food preservation. These uses have continued through the centuries, but new applications are being found at a rapidly increasing rate. In addition to its direct uses, such as for refrigerating brines and soap precipitation, the chemical industry is now making a greater use of salt for its compounds—sodium and chlorine. The sodium is used both in the elemental form as a powerful chemical reagent, and in the manufacture of sodium compounds such as detergents and ceramics. The chlorine from salt is used in the elemental form for such purposes as sterilization and bleaching, and in the manufacture of chlorine containing compounds used for insecticides, humidity control, dust control, and many others. Salt is required in the process of extracting magnesium metal from sea water, a new and important state industry. The new insecticide, DDT, requires salt as a basis ingredient. Likewise, salt in some form has found important new uses in the manufacture of plastics, synthetic rubber and rayon.

During the fourteen-year period from 1931 to 1944, inclusive, the production of salt in Texas increased from 103,040 tons to 1,147,397 tons. Likewise, the total value of this product increased during these years from $486,562 to $3,627,528. Texas now ranks fifth in the tonnage of salt produced by the various states, being exceeded by Michigan, New York, Ohio, and Louisiana.[2]

The salt produced in Texas may be divided into three general types as follows: rock salt, refined or evaporated salt, and salt in brine. Rock salt is obtained by typical underground mining methods from shafts sunk into the buried deposits. The refined product is made by crystallizing salt from brine after being obtained from wells drilled into a salt deposit and treated for the removal of impurities. A relatively crude salt is obtained from sea water or from saline lakes by solar evaporation. The production of salt as brine from wells drilled into buried deposits and used as such in the chemical industry represents the newest and most important application.

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[1] The general term "salt" refers to any compound in which the hydrogen of an acid has been replaced by a metal. This discussion, however, refers only to the salt, sodium chloride, which the mineralogists term halite. Common salt or sodium chloride is made up of 60.6% chlorine, a poisonous yellow gas, and 39.4% sodium, a soft metal. In a pure natural state, it is colorless or white.

[2] Bureau of Mines. Minerals Yearbook.

Eighty-eight of Texas' two hundred and fifty-four counties have reported the presence of salt; sixty in bedded underground deposits, twenty-three in salt domes, and five in surface saline deposits.[3] Rock salt deposits were in all probability formed by the evaporation of ancient seas.

The Permian Basin area of Western Texas contains one of the world's greatest salt reserves. The area in Texas is the southeastern part of a great geosynclinal basin occupying also much of western Kansas and Oklahoma and eastern New Mexico. All the Panhandle and Staked Plains of Texas is underlain by thick beds of rock salt interbedded with anhydrite, sands, clays and magnesium limestones. Of greater commercial importance, however, is the tremendous reserve of rock salt contained in the salt domes of interior East Texas and in the coastal belt of South Texas. These domes occur at irregular intervals all the way from Duval County to the Sabine River, this area being a part of the Gulf Coast salt dome region extending across Louisiana and Mississippi. These domes are more or less cylindrical stocks of salt containing a small percentage of impurities, principally calcium sulphate, which have intruded for thousands of feet through the overlying sediments. This intrusive action of salt is attributed to its property of mobility or flowage under great pressures. The salt is less heavy than the surrounding materials and therefore rises as a consequence of differentials in underground pressures.

These domes usually have a diameter of a little less than a mile and occur at depths ranging from slightly over 100 feet to more than 8000 feet. There are at least 40 shallow domes located along the Texas coast. Assuming an average dome to be three-quarters of a mile in diameter, and the top of the salt to be found at 1500 feet, the volume of salt in one dome to a depth of 4500 feet amounts to more than two billion short tons. The total salt reserve of the State may, therefore, be considered as nearly inexhaustible.

Salt currently is being mined on a large scale by the Morton Salt Company at Grand Saline in Van Zandt County, by the United Salt Company at Hockley in Harris County, by the Southern Alkali Corporation at Benavides in Duval County, and by the Dow Chemical Company at Freeport, Brazoria County. All grades of salt are produced at Grand Saline, from shafts as rock salt and from brine wells. Rock salt is mined at Hockley through a shaft sunk into the salt plug. Production of salt at Benavides and Freeport is from wells, as brine for various types of chemical processing.

The occurrence of salt in Texas has had much to do with the industrialization of the state, the value of the mineral itself being insignificant as compared to the combined value of its many derivatives. Due to its wide distribution and low cost, transportation to point of consumption in industry is an all important factor in considering its strategic value.

The favorable location of salt deposits along the Texas coast adjacent to other natural resources required by the chemical industry therefore could have much to do with the future prosperity of the state.

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[3] University of Texas Bureau of Economic Geology. Mineral Resource Circular No. 29, October 1944.

## SULPHUR RESOURCES OF TEXAS

In one form or another sulphur plays a part in the manufacture of almost anything you can mention.[4] Its uses are so widespread that sulphur has been called the "barometer of business"[5]—because its rate of consumption increases with prosperity and declines with depression.

The uses of sulphur are varied and contradictory: We take sulphur out of natural gas and oil and use it again in the form of sulphuric acid to increase the film strength of lubricating oil and to purify gasoline. We take sulphur out of iron and copper pyrites and use it again in pickling steel and in electroplating processes. We use sulphur to soften wood and to harden rubber, and we use it to kill weeds and grow crops. It is highly corrosive, yet it is used to prepare protective coating for metal surfaces. All of these contradictions are quite confusing to a layman but this versatile element is truly a Jack-of-all-trades and one of the chemist's most convenient tools in all of his processes.

Sulphur is very widely distributed in nature. It is present in the earth's crust, the ocean, in meteorites, sometimes in the atmosphere we breathe and in practically all animal and plant life. Sulphur may be found in the elemental state and as both sulphides and sulphates. Of these sources we are principally concerned here with elemental sulphur.

There are three types of deposits in which native sulphur is found —the volcanic type, formed by the oxidation of hydrogen sulphide escaping from volcanoes, the fumarole or mineral spring type, as found in Yellowstone National Park, and the salt dome type which is by far the most important and is the type of deposit found on our Gulf Coast. The scope of this paper is limited to a consideration of these salt dome deposits which are of primary economic importance by reason of their potential reserves, their productive capacity, the ability to market this basic commodity at a reasonable price, and also the unequaled purity of the product as mined.

These domes occur principally along the upper Texas coast and extend on across Louisiana into Mississippi. Sulphur occurs as a constituent of the caprock overlying a salt dome, this salt having intruded the sediments at great depth from mother salt beds. About five per cent anhydrite ($CaSO_4$) is contained in the salt mass and one theory of the origin of caprock and sulphur assumes that circulating waters dissolved vast quantities of salt during its upward movement, leaving the anhydrite as an insoluble residue on top of the salt. Limestone ($CaCO_3$) and hydrogen sulphide ($H_2S$) were subsequently formed through the reduction of this calcium sulphate by carbonaceous matter, the hydrogen sulphide being eventually oxidized to sulphur. Another theory as to the origin of sulphur is based on the power of certain bacteria to reduce mineral sulphates.

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[4] Some of these uses: In the manufacture of acids, chemicals, cleaning fluids, drugs, dyestuffs, explosives, fabrics, fertilizers, film, food preservatives, fumigants, fungicides, gasoline, glass, glue, glycerin, insecticides, kerosene, leather, lubricants, matches, medicine, paints, paper, petroleum products, plastics, processed foods, refined metals, refrigerants, resins, rubber, synthetic rubber, soap, soda, solvents, steel, sugar, and textiles.

[5] The Stone that Burns—Williams Haynes—page 257.

Sulphur usually occurs as well developed crystal aggregates in the seams and cavities of the porous limestone. The thickness of the sulphur horizon is seldom less than 25 feet and in bodies of commercial size probably averages 100 feet, containing from 20 to 40 per cent sulphur.[6] On the average, these deposits are found at a depth of about 1500 feet.

All sulphur production in Texas of any consequence is carried on by the Frasch or "hot water" process. Sulphur melts at about 240° F. and this unique process consists of pumping superheated water at about 320° F. into the porous sulphur bearing formation through wells equipped with a concentric arrangement of pipes. Superheated water is injected through one pipe, high pressure air through a second, and the sulphur-air mixtures returns through a third.

When Herman Frasch first devised this method of mining sulphur in 1891, his scheme was thought highly impracticable and, in fact, it proved so for many years. It was not until some 12 years after his first successful demonstration of this method that the Frasch process proved economically practical. The first really successful operation of the process got underway at Sulphur, Louisiana in 1903 by Union Sulphur Company and production continued until 1924.

The first sulphur production in Texas occurred at Freeport Sulphur Company's Bryanmound in Brazoria County. This deposit was operated from 1912 until 1935. At one period in its history Bryanmound, with an installed plant capacity of 23,000 boiler horsepower, delivered daily about 9,000,000 gallons of water for mining purposes with a fuel consumption of approximately 4500 barrels of oil. The caprock area comprised about 800 acres of which about 300 acres was classed as commercially sulphur bearing. During the life of Bryanmound, 1897 wells were drilled, resulting in a total production of about 5,000,000 tons, or slightly over 2600 tons per well.

In 1919 Texas Gulf Sulphur Company commenced production at its Big Hill dome in Matagorda County which mine was depleted in 1936. The next mine to come in production was Freeport Sulphur Company's operation at Hoskins Mound in Brazoria County in 1923 and this mine is still in operation. During the six-year period from 1928 to 1933, five more sulphur mines were operated in the Gulf Coast Region, three of which were located in Texas: Duval Texas Sulphur Company's operation at Palangana in Duval County; Texas Gulf's two mines: at Boling Dome in Wharton County and Long Point in Fort Bend County.

Today sulphur is being mined by the Frasch process at the following properties in Texas: Freeport Sulphur Company's Hoskins Mound in Brazoria County, Boling Dome, operated by Texas Gulf Sulphur Company in Wharton County, Jefferson Lake Sulphur Company's Clemens Dome in Brazoria County, and Orchard Dome operated by Duval Texas Sulphur Company in Fort Bend County.

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[6] W. T. Lundy—Sulphur and Pyrites. Industrial Minerals & Rocks 1937.

Successful development of a salt dome type deposit of sulphur by the Frasch process is governed by a number of factors. As the chief use of sulphur is in the manufacture of sulphuric acid, elemental sulphur meets strong competition from sulphuric acid manufactured from pyrite and from reclaimed flue gases. If the sulphur produced is to compete with sulphur from these sources, the deposit must be of substantial size and concentration. The character of the caprock, thickness of sulphur bearing formation, porosity, and depth of the sulphur horizon are important factors. The deposit must be located in a region advantageous to erection of a plant capable of heating from one to several million gallons of water daily. An adequate supply of cheap fuel and fresh water for boilers is also necessary. Sulphur storage space and transportation are other factors which must be taken into consideration.

In equipping a sulphur property for production, the largest single item of cost is the central heating and power plant. This plant must be maintained and operated day and night for an indefinite number of years because interruption in supply of hot water to wells would endanger their loss by freezing of the sulphur. It is entirely possible that a particular deposit might still contain substantial quantities of sulphur and yet its operation might not be justified in view of the heavy overhead.

Altogether some 179 salt domes have been discovered in Louisiana, Mississippi and Texas. Of these 179 salt domes only 11 have produced sulphur in commercial quantities.

Seventy of these salt domes were discovered in Texas, including the northeastern area and south Texas as well as the coastal area. Of these seventy salt domes eight have produced sulphur in commercial quantities, amounting to some 46,000,000 tons to date, valued at about ¾ of a billion dollars.

The Texas sulphur industry experienced a humble beginning in 1912 with total production of only 636 tons. By 1919, however, stimulated by the demands for sulphur during the First World War, production had increased to more than half a million tons. By 1923 Texas had established a substantial lead over Louisiana in production, a lead which it has since maintained. Last year, 1944, Texas produced a total of 2,582,236 tons,[7] as against 635,920 for Louisiana.

The life of the Texas sulphur industry is unknown but it is interesting to note an Associated Press dispatch which appeared in the Dallas Morning News of October 31, 1945, regarding a report by E. W. Pehrson, an official of the Bureau of Mines, to a Senate military subcommittee, as to the exhaustion point for known reserves of certain minerals. This report estimated that the United States supply of zinc would last 19 years; petroleum, 18 years; gold, 14; lead, 12; silver, 11; bauxite, 9; antimony, 4.

As to sulphur, however, the report has this to say, according to the Dallas Morning News, from which I quote:

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[7] At present prices, valued at about $41,000,000.

"By contrast with the minerals he cited as in short supply, Pehrson said known bituminous coal deposits could supply needs for 4,200 years. He estimated iron ores would last over a century, sulphur for fifty-five years and copper for thirty-four—all based on a presumed future consumption at the 1935-39 average".

## ABSTRACTS

### The Rounding of Mineral Fragments

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The purpose of the investigation is to determine, if possible, the effect of abrasion on rock fragments, and to obtain quantitative data on the rate of rounding of different minerals. The common minerals are studied, especially those found in sedimentary rocks. The apparatus used to standardize laboratory technique is described, as well as the new apparatus which will replace the old. The processing of the mineral orthoclase is described.

### The Metals of Texas

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Texas has been a notable producer of mercury and silver. Other metals including iron, copper, lead, and zinc have been mined sporadically. The large potential iron resources remain undeveloped. With growth of its population and with accelerated industrialization, Texas may look forward to increasing development of its large resources of building materials, sand and gravel, rock aggregate, clays and ceramic materials, and other non-metallics.

# SECTION V. CONSERVATION

## PAPERS

## A Dynamic Concept of the Soil

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### I. INTRODUCTION

A. Definitions—

1. Dynamic—Webster's Dictionary gives the derivation of dynamic as from the Greek, meaning powerful, power, or to be able. It is defined as belonging to, or having energy or effective action; forceful.

2. Concept is defined as a notion, thought, or mental impression; idea.

3. Soil—Soil has as many definitions as there are soil specialists. My own definition is that the soil is that portion of the earth's surface used as a medium for plant growth.

B. Introduction—This paper is concerned with my own ideas, designed for effective action, regarding the fundamental nature of the soil and how we can utilize this concept for better agricultural production.

### II. THE NATURE OF THE SOIL

A. Origin—Although we are all more or less familiar with the geologic origin of the soil, we may not be quite as familiar with the pedologic origin.

Historically, our soils are a product of disintegrated and re-synthesized rock and plant remains. Geologically, the materials from which soils have been developed are of various ages, from materials only a few hours old back to as as old as several millions of years.

The mineral constitutions in the soil at any one time and place may have been derived from the underlying parent rock, from glaciers, by the action of the wind, by volcanic action, or by stream, lake, or ocean movements.

As soon as these materials come to rest in any one spot, they are immediately acted upon by many different agencies. Pedologically, the parent material has been acted upon by animals, plants, erosion, leaching, and the climatic factors dominated by temperature and precipitation.

A particular soil in any one location may, therefore, be old geologically, or vice versa.

B. The minerals in the soil—All inorganic matter found in the soil is a result of the residue from weathering and synthesis of a parent rock or from the transportation of weathered and synthesized rock by some geological agency such as water or wind.

We often speak of soil as being productive or unproductive, fertile or infertile, sandy or clay soil, and sometimes as "dirt" land. The above descriptive terms have reference to both the storehouse and the relative availability of all 14 or more elements considered essential to plant growth.*

The available nutrients are the ones that plants can utilize throughout the growing season while the unavailable ones are in some chemical combination not available to the plants during any one season.

C. Organic Matter—The total amount of organic matter in the soil has frequently been assumed as an index of soil fertility. This may or may not be true. The inorganic material that does not decompose acts in the soil only as a physical conditioner. It is really the organic matter that decomposes that is the more beneficial to the plants. It is therefore the speed of decomposition and not the total amount that is a better index of a fertile soil.

## III. A WORKABLE MENTAL PICTURE OF THE SOIL

Sands aid in the soil physically only, while clay and organic matter represent the life of the soil. Clay has a negative charge and will, therefore, attract positive ions. It will adsorb positive ions such as calcium, magnesium, potassium, sodium, and ammonium. The strength of this adsorption is not so great but that plants can utilize these nutrient ions so held by the clay. It is thought that the plant exchanges hydrogen ions for the nutrient cations on the clay crystals. What this means, therefore, is that we have a storehouse of available nutrients in the clay. But the proportion of each nutrient may not be proper for optimum plant growth. Throughout the growing season some of the replaceable nutrient cations which are adsorbed by the plant may be renewed to some extent by the continuous process of mineral breakdown of such materials as feldspars.

Organic materials in the soil of colloidal size (humus) act somewhat as does clay. Under some conditions, however, a part of the colloidal organic matter may act as cations capable of adsorbing such anions as phosphates and nitrates. When we have a mixture of organic and inorganic colloidal particles in the soil, under certain conditions the organic matter itself may be adsorbed by some of the clay. If this condition obtains, the temporary effect would be to diminish the capacity of the clay to supply nutrient cations to the growing plants. When this takes place it would be very likely just temporary, since the organic matter would decompose ultimately to carbon dioxide and water.

## IV. MAN'S USE OF THE SOIL

A. Destructive—If we are to believe some of our leaders, such as Henry A. Wallace, formerly Secretary of Agriculture and at present Secretary of Commerce, we must accept the doctrine that man is an enemy of the soil. Quoted from Wallace in the foreword of *Soils and Men*, the Yearbook of Agriculture of 1939:

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*The 14 elements considered essential for plant growth are: C H O P K N S Ca Mg Fe Cu B Mn and Zn.

"The earth is the mother of us all—plants, animals, and men. The phosphorus and calcium of the earth build our skeletons and nervous systems. Everything else our bodies need except air and sun comes from the earth.

"Nature treats the earth kindly. Man treats her harshly. He overplows the cropland, overgrazes the pastureland, and overcuts the timberland. He destroys millions of acres completely. He pours fertility year after year into the cities, which in turn pour what they do not use down the sewers into the rivers and the ocean. The flood problem insofar as it is man-made is chiefly the result of overplowing, overgrazing and overcutting of timber.

"This terribly destructive process is excusable in a young civilization. It is not excusable in the United States in the year 1938. We know what can be done and we are beginning to do it. As individuals we are beginning to do the necessary things. As a nation, we are beginning to do them. The public is waking up and just in time. In another 30 years it might have been too late.

"The social lesson of soil waste is that no man has the right to destroy soil even if he does own it in fee simple. The soil requires a duty of man which we have been slow to recognize.

"In this book the effort is made to discover man's debt and duty to the soil. The scientists examine the soil problem from every possible angle. This book must be reckoned with by all who would build a firm foundation for the future of the United States.

"For my own part I do not feel that this book is the last word. But it is a start and a mighty good start in helping all those who truly love the soil to fight a good fight."

B. The other side—It is true that our soils in many places have been destroyed; but in so doing we have made a civilization. Why is it not a better philosophy (except for budgetary requests) to consider that what has been is something of the past and that the way out is this direction. For example; farmer Jones has so neglected his soil that his open-land pastures are gullied, his cotton field worn out by sheet erosion and his present methods of up-and-down hill cultivation and overgrazing are definitely bad soil management. The $64 question is—should Farmer Jones be *spanked* or should we gain his confidence and direct him into better farm practices, consisting of:

1. Terracing
2. Contour tillage
3. Proper fertilization
4. The use of adequate cover crops, including legumes and forest trees.

Regardless of the past, Farmer Jones can bring the land around to the point where it is even more productive than it was in its original state. Furthermore, with our present agricultural policies, he can *afford* to adopt these soil building practices because:

1. Farmer Jones can get payment for terracing his lands.
2. Very likely he lives in a soil conservation district and can get excellent cooperation of the SCS.

3. Payments are also available for lime and phosphates.
4. Likewise, legume plantings are encouraged by a subsidy.

The way out is available to all.
Let's quit *spanking* the farmers.
Let's quit looking backward.
Let's improve and build the soil!

## Patrol a Vital Part of Good Game Management

### COLEMAN NEWMAN

Quite often the most important game management technique to be used is the proper handling of the human population. This is especially true in East Texas. With this in mind, no restocking or other forms of development, where an increase of game is expected, need be tried without the services of a competent patrolman for the immediate area. The numerous problems to confront a patrolman should only be trusted with the most capable man available.

The Texas Game, Fish and Oyster Commission, through the aid of the Federal Government, has established areas for the restoration of deer and turkey. Deer and turkey restoration opportunities in Eastern Texas seem unlimited when the amount of desirable habitat is considered. The refuges established by the department are leased from private ranchers, lumber companies, or oil companies. A lease of five years with an option of five more is taken on each area. The lease usually covers all species of wildlife. These selected areas are subjected to all management practices that are considered sound and will be of benefit to the game. This paper will deal with protection which is only one of the numerous techniques used in an attempt to bring the dwindling game populations back to where hunting will once more be considered as good. Patrol of game protection is considered to be of utmost importance in wildlife work in Eastern Texas.

A small amount of illegal hunting is extremely dangerous to a game population that is far below par. Our best stocked refuge areas in East Texas have a very limited breeding stock of turkeys. We have no area that is considered to be well stocked. A prominent authority on turkey management has made the statement that one poacher can systematically remove all birds from most any refuge. Where the turkey population is in the balance it is certainly good game management to prevent the loss of even one bird if at all possible.

Deer and turkey have a tendency to do considerable roaming when released on a new range. This dispersal may be caused from any of a number of conditions. The game may be just curious and want to find out what is in store for them in their new home. A disturbance by some predator may put them on the move. A search for familiar foods and watering places may drive the game into surrounding areas. The real cause may not be any of these mentioned. Regardless of the cause for dispersal, this badly confused game must be provided with as much protection as possible.

In Eastern Texas, most of the habitat surrounding our refuge sites is just as desirable as the refuge. Where a given range is not broken by some natural barrier, the game will have a tendency to roam over a considerable area without being forced by population pressure.

A patrolman should know the location of the game at all times in order to be of maximum assistance. He should also know the residents, the people that visit the residents, and the hunters that frequent the areas where they used to take plenty of game. A good patrolman will know how to discuss the game program with these people in an effort to win their cooperation and confidence. After an area has produced a population that might be considered its carrying capacity, a limited amount of poaching can be tolerated.

After an area in the pine belt has reached a deer population that approaches even one-half the carrying capacity, legal buck hunting will do no harm. Sometimes the Legislature permits an open season to exist on a species that is extremely scarce in the counties where we have our restoration programs.

A patrolman assigned to one of the game department's deer and turkey restoration units has instructions to spend more than half of his time in checking on the welfare of the game that has spread to adjoining areas. Remarkable progress has been made where efficient patrol service has checked illegal hunting several miles from our refuges. A private game reserve in Trinity County has suffered considerably because their patrolman spent all his time inside the pasture. Illegal hunting ran rampant up to the fence and often made sorties onto the reserve. It is difficult to control illegal hunting when it has gone unchecked over a period of years.

Regular wardens have two, three and sometimes four counties assigned to them by the game department. With a territory that large to check, it is impossible to give any particular area special attention. Quite often a hospital receives a patient who requires the services of a special nurse. When we set up a refuge the game supply is rather low and it needs help that only a special patrolman can give.

The work in developing a game population on any area should include all the devices known that will assist in reaching the desired goal. It is useless to plow fire lanes, provide winter greens, plant food patches, clear travel lanes, provide artificial feeding areas, practice predator control, make cover plantings, or do any of the other management practices if the increase game supply is permitted to be killed by poachers.

# Industrial Facilities of the West South Central States

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## THE WEST SOUTH CENTRAL STATES AND INDUSTRIALIZATION

### Introduction

The South today is beginning a revolution in which its social, economic, and political structures will be completely revamped. King Cotton is on its way out but a substitute agriculture has not yet been found. General soil depletion, lack of working capital, inadequate local and domestic markets, and other problems plague the farmer. Mechanization of agriculture and the enlargement of farm units have displaced thousands of farm workers. The war has interrupted readjustments in some cases, in other cases it has stimulated them. The postwar years will undoubtedly see a new South developing. Many resources of a non-agricultural nature are present. Will they serve as a basis for industrialization? To what extent can this portion of the nation look to the factory for its livelihood? These questions must be given careful consideration in order to forestall unwise developments. For this reason this discussion has been prepared.

The United States is a mature nation. During the past four decades there has occurred a notable change in our domestic economy as well as in the character of our foreign trade. We have passed beyond the economic stage of raw material production into a stage of manufacturing. Today, only about 17 percent of our gainfully employed workers are engaged in farming, while about 40 percent are engaged in manufacturing, if we include those workers who are engaged in associated or related industries. According to Case and Bergsmark, in 1860 nearly 70 percent of our exports consisted of crude raw materials and foodstuffs, while in 1937 only 26 percent was in raw form. The evidence is conclusive that the United States has become one of the leading manufacturing nations of the world. With the development of manufacturing has come a degree of material well-being never before experienced in this country or elsewhere. But conditions of well-being are not equitably distributed throughout the United States. This problem constitutes the kernel of the questions considered by this conference.

## PART I—WHY INDUSTRIALIZE

The question may well be asked—why propose a program of development and expansion of industry for the west south central states? According to economic logic, specialization pays rich dividends. This applies to regions as well as individuals. A glance at an economic map of the United States will indicate that this is a basic principle, true in practice as well as in theory. Agricultural production has become specialized by regions. Industry is centered in the North and Northeast, with a few outstanding centers in other parts. The obvious conclusion must be that specialization has paid dividends. No other conclusion may be reached in a society which encourages free enterprise and competition. Why propose a change?

The goal of life is to live, and to live well. This idea applies to individuals but does it also apply to nations? No nation can be considered strong and enduring if there is within it a large minority whose welfare is in a questionable condition. This is the situation in the South today, of which the states of Arkansas, Louisiana, Oklahoma and Texas are an integral part. Franklin Delano Roosevelt termed the South the number one problem area of the United States. In 1940 the Division of Research of the Work Projects Administration made a study of planes of living in rural United States, under the direction of A. R. Mangus. Results were published under the title "Rural Regions of the United States". When the assembled data are shown on a map, in place by counties, the results are astounding. The entire rural South is shown to enjoy a plane of living about 25% as high as the average for all farmers of the United States. This involves nearly one-half of the farmers of our country. While it may be admitted that there are definite weaknesses in a comparison of this type, it is obvious that life in the southern part of our country is definitely unsatisfactory, at least from a national point of view. Something must be done to promote better ways of life in the economically submerged areas. Will an expansion of manufacturing in the west south central states at least help in improving living conditions?

The plane of living map indicates that rural New England lives more than twice as well as other sections of the country. The east north central states, including Ohio, Indiana, Illinois, Michigan, and Wisconsin, enjoy a plane of living about 75% above average. These are the leading industrial sections of the United States. The Statistical Abstract of the United States, 1943, indicates that 76% and 65.5% respectively of the population of these areas were classed as urban in 1940. In the south west central states 39.8% of the population was classed as urban, of a total population 12,176,830. It is granted that the mere fact and presence of manufacturing in the northern sections will not completely explain the difference in rural planes of living, still it has obviously had a favorable effect.

The west south central states do not today have an equitable share of the manufacturing of the United States. While these states comprise 14% of the area of territorial United States, and have 9% of the population, in 1939 this section had 5% of the manufacturing establishments, employing 3.3 percent of the industrial workers, and which turned out finished goods having a value of 4.6% of the total for this country. Furthermore, the Statistical Abstract of the United States for 1943 indicates that with 9% of the population in 1940, the west south central states had 16% of the agricultural workers, including those engaged in forestry and fishing. These figures suggest an obvious reason for directing attention to manufacturing in the Southwest.

TABLE 1

**Regional and National Comparisons**

Data from Statistical Abstract for U. S., 1943

| Item | United States | West South Central States | % total in West South Central |
|---|---|---|---|
| Area | 3,022,387 | 434,883 | 14 |
| Population | 131,669,275 | 13,064,525 | 9 |
| Number Mfg. Estab. | 184,230 | 11,021 | 5.9 |
| Number Ind. Workers | 7,886,567 | 262,583 | 3.3 |
| Value Finished Product | $56,843,024,800 | $2,566,960,233 | 4.5 |
| Number Agric. Workers | 8,475,432 | 1,415,102 | 16 |

Walter Prescott Webb, in his book "Divided We Stand", states that "At the present time the North owns 80 or 90 percent of the wealth in the United States, probably more. Moreover, its proportion of ownership is increasing every year". He adds "In respect to land, the South and the West have far the best of it, a combined area of approximately 79 percent as against 21 percent for the North.—By the same token they would have the same preponderance of the products the land, grass, forests, minerals: i.e., about 80 percent of the total natural resources". Assuming the truth of Dr. Webb's statements, why has the South not profited more from its possession of natural resources? The suggested answer is that the South has lacked the necessary capital for exploitation of its wealth other than soil.

Inasmuch as manufacturing developed early in the history of the North, capital was accumulated with which to further develop the natural resources of the nation. It may be assumed, by analogy, that if manufacturing once successfully begins in the South it will provide the necessary capital means for expansion. It follows, therefore, that the natural resources of the South will be more fully utilized and the plane of living of its people will be raised.

The lack of manufacturing in the west south central group of states causes a continuous drain of human wealth from that section. Limited business opportunities here induce the enterprising young men or women to seek their fortunes elsewhere, primarily in the North, where they may find outlets for their trained skills, with a much wider selection of jobs to choose from. For many decades the census has recorded a migration northward. If it costs in the neighborhood of $10,000 to raise and educate a young man or young woman the loss to the South may well run to astronomical figures. The section needs manufacturing in order to keep its human wealth at home.

Manufacturing today is esentially a phenomenon of machinery. Machines multiply human effort many times and, in spite of the arguments of a current group of scholars, in the long run human welfare is enhanced. Actually, more jobs are eventually available, although in the short run period, many human workers may be replaced by machines. A road maintainer, for example, may immediately displace 50 men, but its construction and use set in motion developments which are far-reaching in their ramifications. Hot dog stands come into being in response to the demands of a travelling public which is on its way to a park which has been opened as a result of better roads. Service stations and over-night camps cater to those who find more leisure time because machines have increased their productive capacity. The South has never used machines extensively, and its productivity has been relatively low on a per capita basis. Manufacturing would logically create more interest in machine methods, an interest which would ultimately spread to agricultural and other non-manufacturing industries.

Many of the products of the west south central states are not in consumable form when they leave the producer. This applies to agricultural, as well as non-agricultural products, fruits and vegetables excepted. Inasmuch as the major consuming markets are in the North, it appears that in many cases processing in the South would be mutually beneficial to producing region and consuming region. For example, Dr. Webb states that in 1929 the South produced 46 percent of the United States lumber crop. Much of this consisted of hardwoods, valuable in furniture and veneer manufacturing. A relatively small part of a raw log finally appears in the finished product but the rough lumber is shipped out of the South, fabricated elsewhere, and at least a portion of the finished product returned to the producing region.

Reasons for the encouragement of manufacturing in the west south central states might be presented in great array. Enough has been said to definitely establish the fact that in the minds of the people of the South a golden era awaits only the time when every town of 2500 inhabitants will have one or more manufacturing establishments. It may be wise to inquire briefly into the condition and extent of the facilities for manufacturing.

## PART II—FACILITIES FOR MANUFACTURING

The *function* of manufacturing is the creation of a product, by hand or machine process, whereby raw materials are converted into a form in which they may be consumed, that is, used. Oftentimes, the product of one stage of manufacturing may be the raw material of a second, i.e., pig iron from a blast furnace becomes the raw material of the steel mill. The *purpose* of manufacturing, as an economic enterprise, is to make profit through the combination of raw materials with labor and capital. Therefore, it becomes obvious that the possession of raw materials is only one leg of a multilegged industrial stool. Because profits are the motivating force behind those who initiate the manufacturing processes many factors, other than raw materials, must be given consideration. Are markets accessible, that is, can the product be put on the market profitably in competition with other producing areas? This is a matter of type of transportation, freight rates, or distance, or more probably, various combinations of all three. Is labor present in sufficient quantity and does it have the required skill? Does the processor possess claim-free patent rights or will he be subject to court action for patent infringement? Can he secure the necessary working capital, available, and in satisfactory form? Any evaluation of the possibilities of manufacturing in the west south central states must take these factors into consideration.

## RAW MATERIALS

### Agricultural

Raw materials of industry may be grouped under the following headings: agricultural, mineral, forest, and fishery. In this paper they will be discussed by groups or types, with little attempt to break the groups down into individual products.

The west south central states undoubtedly possess adequate raw materials of an agricultural nature. The value of all agricultural products in 1939 was $1,345,629,685. This included crops, dairy products, livestock and livestock products. The above figure comprised 14 percent of the value of all agricultural products in the United States. Inasmuch as the west south central states include 14 percent of the total area, and only 9 percent of the population of the country it is obvious that many products of agriculture left this region. Were the surplus products in consumable form when they were shipped to the consumer? In the case of some products the answer is obvious. In 1940, for example, the states of the west south central group produced 50 percent of the United States cotton crop. In the manufacture of cotton goods, however, the situation was entirely different. The 1940 Census of Manufacturing reported that of the 661 establishments in the United States producing broad woven cotton goods, only 27, or 4 percent, were found in the west south central states. Of this number, 21 were in Texas, 4 in Arkansas, while Oklahoma and Louisiana had one mill each. These mills consumed 2.6 percent of all cotton fabricated in this country into broad woven fabrics, and only 2 percent of all cotton manufactured in the United States in 1939.

The woolen textile industry is perhaps more striking than the cotton textile industry relative to the discrepancy between production of raw materials and their fabrication. Texas and Oklahoma in 1940 produced 22 percent of the wool crop of the United States. Practically none of this was manufactured in the west south central states, Texas alone having two woolen textile mills out of a total of 722 for the United States.

The west south central states have made relatively more progress in utilizing cereal raw materials for manufacturing than in the field of textiles. It appears, however, that considerable quantities of cereals are shipped from this region in raw form. In 1939, this section had 7 percent of the mills of the Nation which prepared feeds for animals from cereals. These mills produced 6 per cent of the entire United States output, despite the fact that the west south central states produced 68 percent of the grain sorghum, 11 percent of the wheat, and 8 percent of the corn of the United States. Moreover, these states had 16 percent of all cattle, 11 percent of the swine, and 12 percent of the chickens of this country.

TABLE 2

**Agricultural Production, National and Regional, 1940**

Data from Statistical Abstract for United States, 1943

| Product | U. S. Production | West So. Cent. Prod. | % total |
|---|---|---|---|
| Grain Sorghums | 52,747,000 bu. | 35,511,000 bu. | 68 |
| Wheat | 813,305,000 bu. | 88,542,000 bu. | 11 |
| Corn | 2,462,320,000 bu. | 202,762,000 bu. | 8 |
| Cotton | 12,566,000 bales | 6,093,000 bales | 50 |
| Sweet Potatoes | 70,042,000 bu. | 15,452,000 bu. | 22 |
| All Cattle | 60,675,000 head | 10,510,000 head | 16 |
| Milk Cows | 24,074,000 head | 2,884,000 head | 11 |
| Sheep and Lambs | 40,129,000 head | 9,040,000 head | 22 |
| Swine | 34,037,000 head | 3,806,000 head | 11 |
| Chickens | 337,949,000 | 41,344,000 | 12 |
| Wool | 374,564,000 lbs. | 79,900,000 lbs. | 22 |
| Milk on farms | 11,508,244,000 gal. | 972,253,000 gal. | 9 (1939) |
| Butter, Farm and Factory | 2,194,395,000 lbs. | 183,627,000 lbs. | 9 |
| All Agric. Products | $9,106,045,000 | $1,345,629,685 | 14 |

Cotton is perhaps an extreme illustration. However, these states produce surplus quantities of several of the staple agricultural products. The term "surplus" in this case indicates a production, in terms of United States totals, greater than the percentage of the total population residing in the west south central group of states. Of the 14 products shown in Table 2, ten are produced in this section in amounts exceeding the ratio of U. S. population to west south central population. The figures do not convey the complete picture, however, because it is evident that consumption in this section is relatively lower than that of the average for the whole country. Therefore, it becomes obvious that there must be an adequate supply of agricultural raw materials in Arkansas, Louisiana, Oklahoma, and Texas. The favorable conditions are suggested by the 1940 Census which indicates that between 1937 and 1939 the number of manufacturing establishments increased relatively more in the west south central group of states than in the country as a whole. In this section the increase was from 8572 to 10,021 establishments, an increase of 17 percent, while in the United States as a whole, the increase amounted to only 10 percent. However, during this same period the wage earners in the west south central group of states declined 3.6 percent and the value of the manufactured products declined 4.6 percent. Inasmuch as national figures declined 8 percent and 6 percent respectively it appears that the west south central states continued to enjoy relative advantages in manufacturing. At least, the decline in workers and value of product was not the result of limited raw materials.

## Minerals

The west south central states are richly endowed with minerals having economic value. E. H. Sellards, of the Bureau of Economic Geology of the University of Texas, lists 40 minerals of Texas alone which had been produced to a value of over $5½ billion between 1882 and 1933. Petroleum was not included. The other states of this group, Arkansas and Oklahoma particularly, have abundant mineral resources. The four states produced 25 percent of the value of all minerals of the United States in 1940, with a value of $1,187,173,000. Many of the minerals may be classed as basic industrial raw materials, such as coal, iron ore, lead, and zinc. Others fall into the class of strategic minerals, such as bauxite, sulphur, and magnesium. Still another group includes the earth products such as china clay, brick and tile materials, and cement.

Petroleum holds first place in value among the minerals of the west south central states. According to the Statistical Abstract of the United States for 1943 these states accounted for the production of 778,722,000 barrels of petroleum in 1940, which was 57 percent of the United States output. In the refining of petroleum many by-products were made available, some of which were available for direct and immediate consumption while others served as raw materials for other industries. For example, in 1939, 39 percent of the fuel oil of this country came from the refineries of Texas, Oklahoma, Louisiana, and Arkansas. They also produced 40 percent of the naphtha and benzine of this country, a total of 160,579,533 gallons. Asphalt, other than liquid, was produced in the amount of 401,978 tons, which was 17 percent of the total for the United States. This product, with its associated tar, serves as a raw material in the production of many products.

Other minerals which rank high in the economy of the west south central states are the bauxite of Arkansas, lead and zinc of Oklahoma and sulphur of Louisiana and Texas. The prominence of these minerals is such that they need little more than mere mention in passing. Data are not immediately at hand regarding reserves of these materials. Production figures, however, may suggest something as to their position in the present use of resources. In 1940, Arkansas produced 423,283 tons of bauxite, 97 percent of the United States total. In the same year, Oklahoma produced 21,240 tons of lead and 162,935 tons of zinc which was about 5 percent and 24 percent respectively of the total United States output. In sulphur production this group of states leads the world. According to Bengtson and Van Royen, the production of Texas and Louisiana normally exceeds 2,000,000 tons annually, which is about 99 percent of the United States output and about 85 percent of that of the world.

The question of the economics of an iron and steel industry in the west south central region appears to be debatable. Many alert citizens, as well as active Chambers of Commerce, believe that it is entirely practicable to promote this industry. Others believe that the time is not ripe for such promotion, calling attention to the low quality of ore which is available and to the high transportation costs of coal. The fact remains that there is iron ore in this section which may serve as the basis for an industry in years to come.

The west south central states appear to have an adequate supply of coal for industrial uses. The output of the mines of this section was 3,721,000 tons in 1940, less than 1% of the United States total. However, this is not a measure of the possibilities of production. Future years may experience a greatly expanded output. The quality of much of the coal is low, approaching a high grade lignite, however, along the flanks of the Ouachita mountains the folding of rock layers has generated heat and pressure in past geologic ages which has produced a high quality coal, some of it approaching anthracite in burning qualities.

TABLE 3

**Basic Mineral Production, 1940**

Data from Statistical Abstract for U. S., 1943

| Product | United States | West South Central | % total |
|---|---|---|---|
| All minerals.... | $4,646,533,000 | $1,187,173,000 | 25 |
| Petroleum...... | 1,353,214,000 bbl. | 778,722,000 bbl. | 57 |
| Natural gas..... | 2,812,658 mil. cu. ft. | 1,743,369 mil. cu. ft. | 62 |
| Coal........... | 460,772,000 tons | 3,721,000 tons | 0.7 |
| Bauxite......... | 434,988 tons | 423,283 (Ark.) | 97 |
| Lead........... | 457,392 tons | 21,240 (Okla.) | 5 |
| Zinc............ | 665,068 tons | 162,935 (Okla.) | 24 |

The group of earth materials is rich and varied in Arkansas, Louisiana, Oklahoma and Texas. Utilization in the past is no criterion as to future possibilities. A suggestion as to possible future developments may be gained from the following incomplete list of earth materials, including non-metallic minerals: (from World Almanac for 1944)

1. Chats
2. Clay, China, brick, tile
3. Fuller's earth
4. Gypsum
5. Limestone
6. Magnesite
7. Manganese
8. Mineral Waters
9. Oil stones, etc.
10. Potash
11. Salt
12. Sand
13. Sodium Salts
14. Tripoli
15. Rutile

These materials, and many others not being utilized today, offer outlets for capital and labor, providing other factors are favorable. Emphasis must be placed on the fact that the four states which accounted for 25 percent of the United States mineral production in 1940 have many untouched minerals which may serve as industrial raw materials in the future.

## Forest

Nature has endowed the west south central states richly with forests. The two eastern states of this group were originally covered with relatively heavy stands of timber, while the eastern parts of Texas and Oklahoma had much native timber. Both hard and soft woods were present. Until lumbering expanded in the Pacific Northwest, the South was the principal lumber producing section of the United States. This fact should be borne in mind when considering the forests of the South from the point of view of industrial raw materials. The extent of raw materials is indicated by the fact that the west south central states produced 14 per cent of the United States lumber cut in 1940. Again recalling that only 9 percent of the population is found in this section it is evident that it produces a considerable surplus of lumber. Furthermore, much of this lumber left the producing region in rough form, inasmuch as the west south central states had only 7 percent of the planing mills of the United States. It would appear that with the large supply of hardwoods the production of veneer would be an important enterprise. However, this section produced only 8 percent of the total United States output in 1939. Apparently the plywood industry has not yet been started in the west south central states, Arkansas only having one plywood mill. Of the 8457 finished lumber products establishments in the United States in 1939 (Census of Mfg.), only 452, or 5.3 percent, were located in the west south central section. There is manifestly no lack of forest raw materials in Arkansas, Louisiana, Oklahoma, and Texas.

TABLE 4

**Forest Industries**

Data from 1940 Census of Manufacturing, except first item from Statistical Abstract

| Item | United States | West So. Cent. States | % total |
|---|---|---|---|
| Lumber Production | 28,934 mil. bd. ft. | 3,876 mil. bd. ft. | 14 |
| Planing Mills | 3,076 units | 219 units | 7 |
| Dressed lumber | 15,435,432 mil. bd. ft. | 2,544,532 mil. bd. ft. | 16 |
| Veneer | 1,193,979 log feet | 92,173 log feet | 8 |
| Plywood factories | 86 | 1 (Ark.) | ........... |
| Furniture and finished lumber products | 8,457 units | 452 units | 5.3 |

## Labor

In the section of this discussion which deals with the facilities for manufacturing, only those factors which are favorable will be discussed. Raw materials appear to be adequate. Labor supply likewise appears to favor industrial development. While it is impossible to estimate with any high degree of accuracy the number of workers available at any time, certain trends are suggestive. The high birth rate of the South promises a supply of labor for coming decades. Mechanization of agriculture, resulting in larger farm units, has released many farm workers for industrial work. Moreover, the generally low level of living in the South presents an opportunity for attracting labor through higher wages in the factory. Decentralization of industry into this section is favored by the availability of land for part-time farming, an additional wage factor.

The supply of labor, present and potential, appears to be better in the west south central states than for the United States as a whole. This section had a higher (10.5 per thousand) excess of births over deaths than the average (7.1 per thousand) for the United States in 1940. The ratio of births to deaths has resulted in a total net increase in population greater than that for the country at large. Between 1920 and 1940, the population of the United States increased 11.6 percent while that of the west south central states increased 13.1 percent. Moreover, the people living in the west south central states today are younger than those of the country on an average, thus assuring a better supply of labor in years to come. In 1940, 39 percent of the population of this section was under 20 years of age, whereas, in the United States the total under 20 years was 34 percent. This section has a smaller percentage of workers in the older age groups than the average for the nation, having in 1940 only 8 percent between 50 and 60 years against 10 percent for the country at large.

Not only should industry find labor supplies adequate in Arkansas, Louisiana, Oklahoma, and Texas but the wages demanded should appeal to industry, at least for a period of years. Wages are much lower in these states than in other parts of the country. According to the Statistical Abstract for the United States, median annual wages in 1939 were as follows: Middle Atlantic states, $1010; New England, $940; South Atlantic states, $651; west south central states, $591. The low wages here should be attractive to industry. The lack of mechanical training on the part of labor is not a serious drawback today. Machine processes are so largely automatic that little skill is required to learn to operate a machine. This has been demonstrated time and again in different parts of the world. Henry Ford has found it to be true in this country.

TABLE 6

Farms and Farmers

Data from Statistical Abstract 1943, except last item, from 1940 Census of Agriculture

| Item | 1930 | 1940 | % Change |
|---|---|---|---|
| Number of farms | 1,103,134 | 964,370 | —12 |
| Size of farms: | | | |
| Arkansas | 66 acres | 83 acres | 26 |
| Louisiana | 58 acres | 66 acres | 14 |
| Oklahoma | 165 acres | 193 acres | 17 |
| Texas | 251 acres | 329 acres | 31 |
| All land in farms | 183,906,346 acres | 200,527,329 acres | 9 |
| Number on farms | 5,326,412 | 5,057,011 | —5 |

## Power

The power resources of the west south central states are generally considered adequate for industrial development. Four sources of power are present: coal, petroleum, natural gas, and water power. The ease of transporting the last three makes them readily available to all portions of the region. Coal is rather widely distributed.

The coal resources of the west south central region have not been utilized to any extent. Locally, coal has been produced in considerable quantities in the past but petroleum has largely displaced it for many purposes, particularly in the field of railroad transportation. Present production is largely for domestic purposes but natural gas is offering serious competition in this line of use. Most of the coal of the Gulf Coastal portion is lignite and thus its present uses are limited. The coal of the Ouachita mountain section has been referred to in another connection. Elsewhere, the coal is primarly bituminous and has considerable potential value. The small production (0.7 of total U. S. in 1940) is no indication as to future possibilities.

Future improvements in methods of burning coal should greatly increase the value of this resource. Inasmuch as electricity can be transmitted several hundred miles without undue loss, it is recommended that generating plants be erected at the mine. Except for extreme sections, there are very few parts of the west south central states which could not be served with electricity in this way. Most of the coal is suited to this type of use, and the supply is entirely adequate. Much of the electricity used in the west south central section is now generated in this way, the coal being moved to the generating plant, however. In 1940, 87 percent of the 10,136 million kilowatt hours generated in these states resulted from the use of coal (Statistical Abstract 1943).

In addition to its coal resources, the west south central states are highly favored by having more than their share of the petroleum supply of the section. This condition is especially favorable from the point of view of industrial power since much of the oil of the Gulf coastal section has a high fuel oil content. In 1940, this section produced 39 percent of the fuel oil supply of the country, in spite of the fact that large refining centers are found elsewhere. In many types of demand for fuel, oil is superior to coal because of the ease of handling and storage.

Natural gas has come to be recognized as one of the industrial fuels of the present era. The position of the west south central states in this field is supreme. In 1941, this section produced 62 percent of the national output. Here again is a real invitation for those industries which can best use gas for heat and power. In many ways it is superior to fuel oil. Industry can be assured of cheap and adequate supplies of the mineral fuels.

The water power situation in the southwest is perhaps not as favorable for industrial development as is the case with mineral fuels. This section has utilized relatively little of its water power to date. In 1942, only 9 percent of its total electrical energy output was generated by water power. This was only 1.4 percent of the hydroelectric power generated in the United States that year, and 0.4 percent of the total electric energy produced. The low output of hydroelectric power in the southwest central states may be explained in a number of ways. There has been little demand to stimulate production, there is an inherent conflict of interests between construction of dams for power generation and for flood control, and physical conditions do not favor water power development in most parts. The western sections do not have either a uniform or abundant stream flow and the eastern parts lack the necessary gradient. As a result, this section has only 1.7 percent of the potential water power of this country which is available 90 percent of the time. Other sections are more favored.

TABLE 7

**Potential Water Power, Available 90% of the Time**

Data from Statistical Abstract, 1943

| Region | 1000 horsepower | % of U.S. total |
|---|---|---|
| New England | 988 | 2 |
| Middle Atlantic | 4,895 | 11 |
| East North Central | 869 | 2 |
| West North Central | 1,172 | 3 |
| South Atlantic | 2,936 | 7 |
| East South Central | 2,620 | 6 |
| West South Central | 764 | 2 |
| Mountain | 10,775 | 24 |
| Pacific | 17,734 | 43 |
| United States | 42,753 | ................ |

## PART III — LIMITING FACTORS

It has been shown that the west south central states are advantageously situated with respect to raw materials and labor supply. Is this the case with capital, leadership, transportation, markets, and the other legs of the industrial stool?

### Capital

It is difficult to evaluate the availability of capital for industrial purposes. While the west south central states produce bounteously, they may lack the capital needed to fabricate the raw material. A suggestion as to the amount of available capital may be obtained from a study of deposits in savings accounts and in savings and loan associations. Obviously, there are many other forms in which surplus capital will be placed but data are not readily available. The Statistical Abstract indicates that in 1942 the west south central states had on deposit 682.3 million dollars, which amounted to $52 per capita. This is a large sum of money but does it indicate anything as to the availability of industrial capital? A comparison with the comparable situation in two of the leading industrial sections of the country may be suggestive. For the same date, New England had 5,161.4 million dollars on deposit and the South Atlantic states had 2,641.2 millions. This was a per capita deposit of $615 and $148 respectively.

Dr. Walter Prescott Webb, in his book "Divided We Stand" suggests the same idea in tabular form (P. 23). Demand and time deposits, as of June 1933, were distributed geographically through the United States as follows: North, 79.37 percent; South, including Texas but not Oklahoma, 9.72 percent; and in the West 19.91 percent.

It does not appear that there is enough capital in the west south central states for extensive development of manufacturing.

The west south central section produces 57 percent of the petroleum and 99 percent of the sulphur of this country, along with large amounts of other types of wealth. Why, then, does it not have working capital for further expansion of industry? Dr. Webb again suggests a reason (P. 19) by calling attention to the location of the 200 large non-banking corporations of this country. Ninety percent of them are in the North, while the entire South has only 9, or 4.5 percent. The profits of production therefore leave this section and return to the original source of capital. Illustrations of this type could be multiplied indefinitely. Enough has been given to indicate that if manufacturing on a large scale is to be developed soon it must be done largely with imported capital. There is a possibility that even the capital which is available in the west south central states will hesitate to venture into untried enterprises. A number of influences are present which are rather discouraging, such as a limited local market, discriminatory freight rates for manufactured goods, and monopoly controls through ownership of patents. Experience has made many erstwhile capitalists wary of new ideas.

In spite of the discouraging outlook presented above there are obvious opportunities for the use of local capital. The west south central section does have raw materials and it does have labor. It does have capital and it does have markets, even though they may be limited. A suggestion may be found in the census recorded increase in manufacturing establishments between 1937 and 1939, an increase of 17 percent. These plants were widely distributed, of low capitalization which was supplied locally, employed a small number of workers and served local markets. In this way reserves of capital may be built up which may facilitate expansion programs if, and when, the time arrives when retarding influences may be removed.

## Markets

Markets for manufactured goods may be local, domestic, or foreign. In a region which is not industrialized the first and principal markets must be local. Domestic and foreign markets may develop later. For this reason the possibilities of local markets will be investigated first, and emphasized. The extent of local markets depends upon a number of factors, chief among them being the character of local buyers, including their purchasing power, sales appeal of the product, and the competition of outside producers. Established competition is hard to overcome. Buyers have become accustomed to certain types of goods and it is frequently difficult to induce them to try a new type or brand, which may, in all ways, be superior.

In a number of ways, local markets (markets within these states) in the west south central states are not particularly encouraging, especially from the point of view of young industry. This section is notoriously conservative. Long periods of precarious living have created a pathetic acceptance of the status quo. Inertia is a dominating characteristic. Only time, with better incomes and education, will minimize this condition. Incomes are definitely below the United States average in the southwest. In 1942, which experienced the beginnings of actual wartime inflation, this section received 7 percent of the national income of this country. To bring this figure in line with national averages, about 2⅓ billion dollars of additional income would have been necessary, inasmuch as this section has 9 percent of the population of the United States. This would have meant an additional per capita income of $182. This amount would have been a substantial increase in income, even with wartime prices. A more accurate picture of normal incomes may be had from a study of pre-Pearl Harbor conditions. In 1940, the per capita income in the west south central states was $376, which was 36 percent below the national average of $581 (Statistical Abstract for 1943). In this case, averages may not present the clearest picture. It must be remembered that in these states incomes are not at all uniform. In fact, the opposite condition prevails. In 1940, the largest group of workers who had no incomes other than wages, were in the $1 to $399 group, comprising 36 percent of all workers. Even among workers who had other sources of income, 35 percent were in this income group. To further emphasize the fact that incomes are very low in the west south central states it may be noted that the income of those whose only source of income consisted of wages, salaries, and commissions received only 4.5 percent of the national total for this type of income.

As further evidence that purchasing power is low in the west south central states, attention is called to the fact that while this section has 9 percent of the total population it contributed only 3.9 percent of total income tax payments to the federal government in 1939 (World Almanac 1944). The average income tax payment for this section was $355 on each return, an amount 38 percent below the national average.

It is now evident that local markets of the west south central states leave much to be desired. This suggestion is presented, not with the idea of discouraging attempts to industrialize the area, but to caution against undue optimism. Local markets do exist and they may well be served by local industry. But local marketing conditions should be carefully studied before capital is invested in local enterprises.

In view of the limited purchasing power of the south western states it may be well to briefly review types of manufactured goods which are consumed by our people. The high income groups demand high quality products but they comprise a relatively small percentage of our population. The mass of consumers are able to buy little more than the bare necessities of life. Manufactured foodstuffs, cheaper types of fabrics and wearing apparel, durable but cheap household furniture, and the simple types of farm tools could be produced and sold locally. It is assumed, of course, that competition can be met. To produce high quality goods on a large scale would be extremely difficult for some years to come. This would require markets in distant places. Other producers already have those markets, to say nothing of freight rate handicaps, monopoly control of patents, scarcity of skilled labor, lack of capital, etc.

Dr. Webb illustrates vividly one of the local marketing problems which is frequently encountered by young industries in a society which protects monopoly through patent rights. Chapter 6 of his book "Divided We Stand" covers the story of the struggles of a young Texas corporation against the pressure of a large eastern concern. The Texas corporation began business manufacturing glass milk bottles, using local supplies of silica sand, lime, and feldspar. Electric power was available, a large and growing market awaiting cheaper milk bottles was at hand, and local people supplied the necessary capital. The prospects of a profitable business were extremely good.

A few months after the factory opened for business, after it had established itself, the president of the corporation was called upon by representatives of the Hartford Empire Glass Company of Hartford, Connecticut. They claimed that the young company was using a machine on which they owned patent rights and for the use of which a royalty must be paid, inasmuch as it was the policy of the Hartford Empire Glass Company not to sell the machines but to rent them. Refusal on the part of the Texas Company to meet the terms of the eastern corporation resulted in suit being filed in federal court. To obviate a costly trial the Texans agreed on a settlement which involved their acceptance of $10,000 as a refund on the machines, and payment of a stipulated royalty on the factory output. A contract was drawn for a period of six months, the Hartford lawyers explaining that it was a policy of their clients to give contracts for short periods only. At the end of four months of the contract period the bottle company was notified that the contract would not be renewed and that the machines would have to be returned. After the removal of the bottle making machines, production was continued for a time using hand processes. Later the factory was purchased by an out-of-state concern which was in good standing with the Hartford Empire Glass Company. Soon afterward the machinery was destroyed and the building razed. And so ended an attempt at local industrialization. Here, truly, is an obstacle. The state government cannot help, inasmuch as patent rights are protected by the federal government. The owners of patents are interested in the returns on their issued stock, not in the industrialization of the west south central states. Therefore, it appears that only as permission to produce is purchased from them, can many types of industry come into being in this section.

It is needless to state that it would be more difficult to secure markets outside these states than within. The monopoly controls over the established markets elsewhere could hardly be broken. Their influence would be much greater because of established market bonds. The same is true of foreign markets. Therefore, further studies of markets and marketing must concentrate on local markets.

## Transportation

The discussion of transportation facilities of the west south central states is included with the limiting factors because today some aspects of the transportation factor are unfavorable. The physical facilities for land transportation are adequate but this advantage is offset by unfavorable freight rates. The freight rate structure will doubtless be revamped some day but at present it appears that this section is handicapped.

The south west central section is nearly as well equipped with all-weather roads and railroads as the United States as an average. Obviously, the congested parts of the North and East have an advantage in this respect, however, the Southwest has an excellent system of primary highways, which is of basic importance from a distribution point of view. This section had 9.3 miles of surfaced road for each 100 square miles of area in 1940, compared with 10 miles for the United States. Nearly all parts are within 10 miles of a surfaced road. In the same year the west south central states had 31.2 miles of surfaced roads for each 10,000 inhabitants as compared with 32.6 miles for the United States.

The railroad situation is just as satisfactory from a marketing point of view as the highway. In 1941 the west south central states had 7.1 miles of railroad for each 100 square miles of land as compared with 7.6 for the nation. A railroad map indicates that all parts are readily served by this type of carrier except for a few very rough sections.

Highways and railroads supplement each other in serving the needs of the west south central states. Apparently the shipping needs of this section require the use of trucks extensively. In 1942, this section had more trucks per person than other sections, there being 1 truck for each 23 persons as compared with the United States average of 1 truck for each 32 persons.

TABLE 8

**Transportation Facilities**

Data from Statistical Abstract for 1943

Surfaced roads—1940; Trucks—1942; Railroads—1941

| Item | United States | West South Central States | % total |
|---|---|---|---|
| Miles of surfaced roads | 305,615 | 40,588 | 13 |
| Miles per 100 sq. miles area | 10 | 9.3 | .......... |
| Miles per 10,000 population | 32.6 | 31.2 | .......... |
| Miles of railroads | 231,971 | 31,230 | 13 |
| Miles per 100 sq. miles area | 7.6 | 7.1 | .......... |
| Trucks, number | 4,608,088 | 556,422 | 12 |
| Persons per truck | 32 | 23 | .......... |

The above data indicate that land transportation facilities are adequate to serve the needs of industry at present. Growing industrial needs can be met through an increased use of trucks, and there is no evidence that the railroads cannot handle any conceivable amount of factory products. Witness the efficiency with which they have handled the needs of a nation at war.

During recent years there has been a continuous and growing agitation for the improvement and extension of our inland waterways. There is a question as to the feasibility of river traffic in most portions of the west south central states. Here again, nature has not been very kind. Most of our streams are raging torrents during and after rains but merely dry channels during many months of the year. The maintenance of anything approaching a uniform flow would necessitate the expenditure of hundreds of millions of dollars for dams. If such construction were in conjunction with the development of hydroelectric power a conflict of interests would occur. Power production calls for as great storage of water as possible and the heavy demand for water for river transportation during dry summer months might prove embarrassing for the power companies. Without dams, river navigation is obviously impractical. Even the shallow draft landing craft, travelling without cargo, which ascended the Red River recently, encountered trouble. It appears that the principal value of river transportation in this section would lie in its effect upon railroad rates. The threat of competition might force the railroads to lower their rates, as has been the case elsewhere. The New York state barge canal is an excellent illustration. A few thousand tons of freight move over this route annually whereas the paralleling railroads carry millions of tons. Moreover, our streams do not flow in the direction of present day markets. Assuming an expansion of manufacturing in this section, to a point where large quantities of products would be sold on foreign markets, our rivers may logically be developed as a part of our transportation system. In the meantime, their value is questionable.

No discussion of transportation as related to industrialization would be complete without a consideration of freight rates. This matter has been a topic for discussion for many years. When our country was young and relatively sparsely populated, railroad freight rates necessarily were high. The practice developed of "charging what the traffic would bear". In more populous sections enough goods moved to permit competition to adjust rates but in the sparsely populated areas this could not happen. Thus freight rates differed from place to place. As the country expanded internally, especially after the Civil War, railroads penetrated to all parts. Regional specialization was based upon a free movement of goods from the producing areas to the regions of consumption. But unlimited specialization may not promote the best welfare of all regions; economic instability may ultimately be the result. Some resources may become depleted while others, as yet unused, may become prominent. The necessary shift in production from one type to the other may be retarded if freight rates impose handicaps and the welfare of the entire nation may thereby be jeopardized.

As the railroads spread their networks throughout the United

States rates were devised for different sections which seemed to be in keeping with the conditions and needs of the respective areas. With the passing of time, the boundaries of these sections became more distinct and within each region there was relative uniformity of freight rates for specified classes of goods. However, similar types of goods originating outside a rate territory faced a higher rate than that paid by goods produced within the territory. Thus, competition was discouraged. This appears to be the basis for the continued interest in freight rates. The west south central states, facing a decline in agriculture, are forced to turn to the use of resources other than agricultural, in order to maintain their economic stability. It is commonly believed that present freight rates are highly detrimental to any attempts to industrialize this section. Inasmuch as regional markets are definitely limited here, markets must be found elsewhere. If freight rates on manufactured goods from this section are higher than rates on similar goods from other producing areas, west south central producers are definitely handicapped.

The existence of territorial freight rate barriers has been officially recognized by the federal government. In 1934, Federal Coordinator of Transportation Eastman reported to Congress, "—An objectionable phase of the railroad situation for many years has been the maintenance of regional differences and distinctions, which are very imperfectly related to differences in costs and of territorial boundary lines (Chinese Walls) where rate systems and practices change. It has tended to provincialize the railroads and discourage national unity".

The foregoing quotation verifies the existence of freight rate differences which have been, and are today, antagonistic to the development of manufacturing in the west south central states. It should be observed, however, that the freight differentials probably had little adverse effect upon the welfare of this section while it was fundamentally agricultural. The demand for products of the farm was such that this section could dispose of its products in the northern and eastern markets and still have a fair margin of profit. Exceptions were frequent and in some cases the producer had little or nothing left after paying freight bills. The farmer within the rate territory where the produce was sold had a definite advantage over the outside producer. In the case of freight rates on manufactured goods, however, it is doubtful if the west south central section has been harmed greatly in the past. Freight rates on manufactured goods originating in the North and East moved at rates lower than those for similar goods originating in this section. Thus, the consumer has profited in a way. Today, the situation is reversed to the extent that the west south central states are attempting to improve their material welfare by manufacturing. The high freight rates on goods originating in this section place our manufacturers at a competitive disadvantage with the manufacturers of the North and East. This may apply to markets within these states as well as to out-of-state markets. For example, manufactured goods from Illinois bear a lower freight cost when sold in Little Rock, Arkansas, than do goods produced in Louisiana or Texas and moved the same distance to that market. This is definitely discouraging to the Southwest.

A few examples of rates on first-class freight in the southwestern territory compared with rates in the eastern or official territory may prove to be enlightening.

Rates Stated in Cents Per 100 Pounds

| From | To | Miles | First-class rates |
|---|---|---|---|
| | Zone III | | |
| Little Rock, Ark | Decatur, Ill | 454 | 154 |
| Springfield, Ill | Cleveland, Ohio | 454 | 106 |
| Difference (in favor of the eastern shipper) | | | 48 |
| Shreveport, La | Cincinnati, Ohio | 808 | 215 |
| Cincinnati, Ohio | Holyoke, Mass | 808 | 143 |
| Difference (in favor of the eastern shipper) | | | 72 |
| Dallas, Texas | Chicago, Ill | 905 | 237 |
| Chicago, Ill | Burlington, Vt | 909 | 154 |
| Difference (in favor of the eastern shipper) | | | 83 |
| Galveston, Texas | Indianapolis, Ind | 997 | 252 |
| Indianapolis, Ind | Portland, Me | 1009 | 155 |
| Difference (in favor of the eastern shipper) | | | 97 |
| Texarkana, Ark | San Angelo, Texas | 454 | 170 |
| Decatur, Ill | Little Rock, Ark | 454 | 154 |
| Difference (in favor of the eastern shipper) | | | 16 |
| New Orleans, La | Amarillo, Texas | 852 | 246 |
| Grand Rapids, Mich | Fort Smith, Ark | 851 | 214 |
| Difference (in favor of the eastern shipper) | | | 32 |
| Texarkana, Ark | El Paso, Texas | 830 | 270 |
| Columbus, Ohio | Fort Smith, Ark | 834 | 212 |
| Difference (in favor of the eastern shipper) | | | 58 |

These comparisons were taken from House Document No. 264, 1st Session of the 75th Congress, which dealt with "The Interregional Freight Rate Problem of the United States," a survey conducted by the Board of Directors of the Tennessee Valley Authority, dated 1937. It will be noted that in every instance the advantage in freight rates was in favor of the manufacturer outside of the west south central section. Rates on first-class freight only were presented. The same relationship is found in the case of special commodities. The following comparisons of commodity rates between the southwestern section and the official or eastern territory were taken from the source quoted above.

| From | To | Miles | Rates in Cents Per 100 Lbs. |
|---|---|---|---|
| **Glassware** | | | |
| Fort Smith, Ark | Peoria, Ill | 569 | 66 |
| Muncie, Ind | Washington, D. C | 589 | 43 |
| Difference | | | 23 |
| Tulsa, Okla | Chicago, Ill | 679 | 71 |
| Marion, Ind | Richmond, Va | 685 | 46 |
| Difference | | | 25 |
| Shreveport, La | Indianapolis, Ind | 733 | 71 |
| St. Louis, Mo | Batavia, N. Y | 731 | 48 |
| Difference | | | 23 |
| **Cotton Fabrics** | | | |
| Dallas, Texas | Springfield, Ill | 726 | 96 |
| Aurora, Ill | Roanoke, Va | 702 | 77 |
| Difference | | | 19 |
| Little Rock, Ark | Toledo, Ohio | 738 | 88 |
| Rockford, Ill | Williamsport, Pa | 741 | 79 |
| Difference | | | 9 |
| **Canned Goods** | | | |
| Fort Smith, Ark | Indianapolis, Ind | 650 | 71 |
| Indianapolis, Ind | Baltimore, Md | 650 | 45 |
| Difference | | | 26 |
| Houston, Texas | Indianapolis, Ind | 963 | 91 |
| Indianapolis, Ind | Fall River, Mass | 960 | 53 |
| Difference | | | 38 |

Commodity rates, as with first-class rates, appear to favor the shipper in the eastern section of this country. In many cases his rate is not more than 50 percent as high as that of the west south central shipper. The advantages of the west south central manufacturer in regard to raw material and labor supply can hardly compensate for his disadvantage in marketing his goods. It appears evident that a material adjustment in interregional, as well as intraregional, freight rates must be secured before the west south central section can expect to become industrialized.

Within recent weeks an Interstate Commerce Commission ruling has established uniform class rates for freight moving in and through the rate territories east of the Rocky Mountains. The west south central section should be the chief beneficiary of this ruling because this section has had the highest rates of any part of the country. Texas should profit the most of the four states in this group. This ruling has been hailed by those who are interested in the industrialization of the Southwest, believing that it removes the last difficult barrier to manufacturing. Under the provisions of the ruling of the Interstate Commerce Commission there is prescribed a 10 percent reduction in freight rates in the freight territories east of the Rocky Mountains, excepting the eastern or official territory in which rates were increased 10 percent. This measure would tend to equalize marketing costs and remove a long-existing inequality. On the same date, May 20, 1945, the Commission also ordered a nation-wide application of a uniform classification system, so that an article will fall in the same rate category no matter where it is shipped.

The ultimate results of the action of the Interstate Commerce Commission cannot be foretold at this time. Only class rates, which from the standpoint of traffic tonnage are the least important of the different kinds of rates, were involved in the proceeding. The ICC made a study of all carload traffic transported on September 23, 1942, and found that only 4.1 percent moved on class rates, 10.7 percent on exception rates, and 85.2 percent on commodity rates. For this reason the west south central section should view the rate reduction only as an initial move in a process which probably will require several decades to achieve. According to transportation experts present class rates in the southwestern rate territory average 35 percent higher than those of the official territory. Under the ruling of the Interstate Commerce Commission, effective August 30, 1945, southwestern rates will still be materially higher than those of the northeastern part of the country. Consequently, discriminatory freight rates will continue to be a deterrent to extensive industrialization in the west south central states.

## Summary

In summarizing the facilities of manufacturing in the Southwest it appears that this section is unusually well provided with raw materials, from its farms and ranches, from its mines, and forests. It also has completely adequate supplies of power from its oil and gas fields and from its coal deposits. In places, water power may supplement other forms. The industrial labor situation is likewise favorable for the present and promises to be adequate to meet future needs.

On the other side of the ledger it appears that the Southwest is not overly well endowed with industrial capital or markets to support very much manufacturing. An additional handicap is found in the lack of technically trained leaders, as well as the control of basic patents by northern corporations. Unfavorable freight rate structures likewise are discouraging.

In balancing the two sets of factors, those which favor industrial development against those which handicap, there appears to be a definite note of optimism. This section does have 13 million potential buyers of manufactured goods, much of which is now being supplied by factories outside this region. The population here can and will provide some industrial capital, and freight rates can be modified if enough pressure is brought to bear upon the Interstate Commerce Commission. Also, with an increase in technical training, as well as the establishment of research foundations in this region, the Southwest can train leaders who can develop ideas which may be used here. Modification of patent laws, along with education in regard to their use, may simplify the growth of manufacturing. The long time results will depend, in large measure, upon how diligently the people of the Southwest attack these problems affecting their welfare.

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# WILDLIFE PAPERS

Wildlife Society, Region 5; Cooperating with Conservation Section,
Texas Academy of Science

## Upland Wildlife Resources of the Southern States

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### INTRODUCTORY

Among the great regions of the United States the South (including the Southeastern States, Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia; and the Western Gulf States, Arkansas, Louisiana, Oklahoma, and Texas) is notable for its actual and potential wildlife.

One obvious reason for this is the great expanse of the region, for other things being equal, the larger the area the greater the variety and quantity of its wildlife. The proportions of southern lands give them an unusually wide range of topographic, soils, and climatic conditions, which inevitably results in a profusion of plant life ready for translation into the bodies of living animals.

Of the many ways in which the 13 southern states are unique among wildlife areas of the North American continent, six may be selected for special mention.

(1) The word "South" is key to the unlocking of important subtropical resources not only in plant but in animal life. Lands in Florida and Texas drive far south (Florida to latitudes below 25 degrees north latitude) and even the Gulf Coast partakes of some of the essentially tropical fauna and flora.

(2) The bayous, bottomlands, and swamps, "waste areas" of the South, are now recognized for the jewels they are in the grand kaleidoscope of Nature. Among these are the Dismal Swamp of Virginia and North Carolina and the Okefinokee of Georgia and northern Florida, not to mention the Everglades and the extensive coastal marshes and bottoms from east to west, north to south, in the other southern states. These low-lying tracts, seemingly undecided as between land and water, are natural biological museums laid out on a magnificent scale, possessed of surpassing attractiveness and beauty.

(3) Within their borders the southern states have a large part of the most important range of the bobwhite quail, which, by common consent, holds "first rank among game birds of the country".

(4) The southern states possess more wild turkeys than all the other states together.

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*Fish and Wildlife Service, United States Department of the Interior, Texas Agricultural and Mechanical College, Texas Game, Fish and Oyster Commission, and American Wildlife Institute, cooperating. Grateful acknowledgment of assistance in the preparation of this paper is made to Dr. Allen M. Pearson, Alabama Cooperative Wildlife Research Unit, Auburn, Alabama, and Charles O. Handley, Virginia Cooperative Wildlife Research Unit, Blacksburg, Virginia.

(5) On the Gulf Coast, particularly in Louisiana, the fur resources surpass in value those in any area of similar size in North America.

Possibly more interesting than any of these other features, however, is the fact that

(6) The Gulf Coastal region constitutes the wintering ground of literally hundreds of varieties of birds and millions of individuals which summer and nest to the North.

These include a host of song and insectivorous birds, hawks, owls, and others; also a majority of the waterfowl (ducks, geese, and swans), which in the late summer and fall of each year gather more than 100 million strong on the lakes, marshes, and prairies of the Gulf Coast.

The mind of the South has been pointed steadily toward life in the open (Cash, the Mind of the South, 1941). In this great out-of-doors region guns, dogs, and horses come into their own. Hunting, fishing, and out-of-door pursuits generally, in their proper place, are among the few human enterprises of so stimulating, healthful, and inspiring a character as to be in themselves ends and objectives of living.

Nor will the anticipated trend toward the development of manufacturing and service industries, so urgently needed in the South, necessarily interrupt the development and maintenance of our native plants and animals. Few or no states in the Union are more highly industrialized than Pennsylvania and Michigan, although these states are famous all over the Nation for the quantity of their wildlife.

## SOME SOUTHERN WILDLIFE RESOURCES

### Small Game

Doubtless of far greater importance than the more spectacular big game are some of the smaller species which one may so easily overlook. For the relatively large number and wide distribution of such animals as bobwhite quail, mourning dove, cottontail, opossum, and squirrel make up for their smaller size. Furthermore, some of these, especially the mourning dove and bobwhite quail, offer as fine sport as any game that moves.

Found on the long and tortuous coast-line of the southern states, as well as along inland waterways, are numerous shore birds, most of them protected at all times under federal and State laws.

In South Texas the white-winged dove is extremely popular, attracting sportsmen from all over the country to the lower Rio Grande Valley for the short open season in late summer or early fall.

There are also the rails and gallinules, occurring as residents in all suitable habitats throughout the South; the woodcock, a rare resident and a relatively more numerous winter visitant in many parts of the area; the lesser prairie chicken, found sparingly in Northwest Texas and in western Oklahoma; and the greater prairie chicken, formerly, or at present, recorded from Northeast Texas, Arkansas, and western Kentucky. In parts of Arkansas, Tennessee, and Virginia is found the ruffed grouse, whose fascinating woods antics, particularly its "drumming", have caught the imagination of all.

Whether the gray and red foxes should be regarded as small game, fur animals, or predators will doubtless depend somewhat on one's likes and inclinations. On this question, indeed, there is marked difference of opinion within our boundaries.

Pheasants and Hungarian partridges, which are so popular in some parts of the North, do not do well in the South.

## Waterfowl

Altogether the waterfowl family (ducks, geese, and swans) contains about 225 forms distributed throughout the world (Kortright, The Ducks, Geese, and Swans of North America, 1942, p. 1).

Of these 57 kinds are native to North America. A few of these (the Hooded Merganser, Florida Duck, Mottled Duck, Cinnamon Teal, Shoveller, Wood Duck, Black-bellied Tree Duck, and Fulvous Tree Duck) breed occasionally or regularly within the boundaries of the thirteen southern states.

But in winter the waterfowl congregate in the South like tourists in the Riviera. As Phillips and Lincoln (American Waterfowl, 1930, p. 40) have pointed out, "From the Delta of the Mississippi westward along the whole coast of Louisiana and Texas and extending south along the coast of Mexico to beyond Tampico, we have probably the most important single (Waterfowl Wintering) region . . . in all North America."

In a very real sense the waterfowl of a continent depend on the safety and security of these winter visitors in southern territory. Great expanses of continental breeding grounds in the United States, Canada, and Alaska produce birds to fill our winter flocks. Our responsibility is great to properly care for them during the cooler part of the year.

## Big Game

Jackson (Research Report 8, Fish and Wildlife Service, U. S. Department of the Interior, 1944, p. 13) lists 9 species of big game in the 13 southern states. These include the elk, extirpated from our region many years ago, now reintroduced in Arkansas, Oklahoma, Texas, and Virginia; the American bison or buffalo, exterminated in the late 1800's, represented by herds in semi-captivity in Oklahoma and Texas; the black bear, formerly extremely numerous in suitable localities throughout the South, and still found, usually in distressingly reduced numbers, in all the southern states except Oklahoma; the European wild boar, the only foreigner listed here, introduced in North Carolina, Kentucky, and Tennessee; the collared peccary, furtive inhabitant of the brush country of South Texas, still present in some numbers although severely reduced in population and crowded out of much of its ancient hereditary range; desert bighorn, hanging on precariously in a few mountain ranges of Trans-Pecos Texas; prong-horned antelope, one of our most unusual species, uniquely American, represented by a pitiful remnant in Oklahoma and, fortunately, a fairly good population in Texas; mule deer, found in the Trans-Pecos section of Texas and far western Oklahoma only; and more important as well as more numerous than all the others put together, the Virginia or white-tailed deer, which occurs in every southern state, where it is found from an estimated 3,306 in Kentucky to 303,735 in Texas.

## Fur Animals

From time immemorial furs have been luxuries in southern climates and necessities to dwellers in colder regions. The demand for furs has been more or less constant from the dawn of recorded history.

The most important fur animals in the South are the muskrat, mink, opossum, raccoon, skunks, ring-tailed cat, beaver, and otter. Probably the gray and red fox also should be included.

A few years ago the annual value of the Texas trade in raw furs was estimated at $3,000,000; it probably still pays something like a million dollars a year to the trappers of Texas. These men, mostly farmers and farm boys, really need the income from furs. The records indicate that one Mississippi farm lad, over a 10-year period, made an average of 75 cents an hour and $1.10 per acre from trapping the furs on the family farm. Some of the bottomlands in other southern states should do as well. In what other activity can the farm boy of the South make money at the rate of 75 cents an hour? Do other farm or forest enterprises on southern bottomlands produce as much?

While the fur resources are important and widely distributed throughout all the South, Louisiana is preeminent among all of them and indeed among all states in the Union and the provinces of Canada.

## Non-Game Species

We have referred already to some of the non-game species of spectacular interest. Many others deserve mention. As previously indicated, the South, by virtue of its position as a wintering area for hundreds of migrants (non-game as well as game species), its inclusion of numerous convenient flight lines, its long frostless season, and its generous and sometimes even luxuriant food and shelter resources for birds, is with little doubt the outstanding region in the United States for non-game wildlife, both birds and mammals, as well as the strictly game species.

While the non-game species ordinarily receive far less attention than the game, at least from sportsmen, they are an essential feature in the organic balance of life. Some serve as food for game; some consume insects; others serve as food or give their substance for numerous articles of chemistry or commerce or the laboratory. Some are pests, some carry the vectors of disease. Each is interesting in his own right and worth knowing. Sometimes such acquaintance is not only interesting but significant to human welfare.

## Predators

In passing from one state to another in the South we find that quite different animals are listed as predators, to be left unprotected under the law, and indeed in some instances subjected to control. It is the usual thing to regard the coyote, wolf, bobcat, and mountain lion as predators wherever they occur, with, among birds, the great horned owl and the blue darter hawks (sharp-shinned hawk, Cooper hawk, and goshawk). But with reference to other hawks and owls among birds, and the gray fox and black bear among mammals, there is more difference of opinion.

Obviously there are some species of animals, such as the brown rat and the mosquito, which are predators in fact, and all the time. But the status of most species varies with circumstances. Thus a deer may be a prized game animal in a live oak-savannah far out on the Divide in Texas, while the same deer in an oat field near headquarters may become a pest!

The more we learn of the ways of our furred and feathered friends, the less inclined we are to make snap judgments, the more reluctant we become to pass sentence of death on entire species.

## SOME VALUES AND INTIMATE INTERRELATIONS OF WILDLIFE

Among the scenic features and tourist attractions characteristic of a region, the wildlife should not be overlooked. In many instances visitors and residents too are more interested in seeing a bit of living wildlife than some great inert inorganic attraction. What could be more inspiring or absorbing than a flock of roseate spoonbills circling in the sun over their coastal island habitat along the southern Gulf Coast; or perhaps 20,000 waterfowl rising suddenly from a pasture or pond on which they may have been feeding; or a group of white-tailed deer feeding or playing in the half-open habitat so much favored by these animals, whether along the coast or inland?

To summarize, it is obvious that wildlife resources are closely interrelated with human resources. There is not only the esthetic side, but some very important economic phases to be considered. Some species may transmit disease to animals or mankind. Thus the rat often becomes a carrier for typhus fever or some of the other dangerous epidemic diseases which may seriously affect human health. Wildlife is intimately related also to land use, since game production depends upon proper land management. The soil cannot do what it should, even in producing crops, unless it has a proper complement of animals and plants, including microscopic forms, as well as invertebrates and some of the backboned species. The relationships of wild game and domestic livestock again illustrate the intimacy of the relationship between the wildlife and human concerns. Wildlife is an important source of food. Wildlife, especially the fur animals and those which produce valuable hides or feathers, enters into the production of human clothing and shelter. In the field of recreation wildlife makes one of its highest contributions to the welfare of mankind. Especially in times of stress, which often arise in a competitive society, we need the inspiration and reinvigoration which are associated with out-of-door living and in which wildlife—hunting and fishing or just plain observing, watching, picnicking, hiking, or photographing—plays such an important part.

## MAN CANNOT LIVE WITHOUT NATURE

Wildlife should be understood to include not only game species but all wild living creatures. While many of the values quoted have related almost exclusively to game, it must not be thought for an instant that other forms are not important. The preferential attitude which maintains that only game species are worthy of conservation is most unfortunate. It should be emphasized again and again that the fur animals, the insect-consuming forms, indeed all natural wild creatures, have a part to play in the economy of nature. In plans for conservation man should consider all wild species of animals whatever. "The beautiful is as useful as the useful", said Victor Hugo.

Another great Frenchman, the historian and essayist Michelet, says, "Birds can live without man, but man cannot live without the birds". This statement can be extended and fairly stated in the following form: Nature as a whole, in its manifold beauty and harmony, can exist without man, but man cannot exist without Nature.

## WHAT IS HAPPENING TO OUR WILDLIFE IN THE SOUTH?

### Exhaustibility

From the earliest time the explorers and settlers of America, and of the South, evidently have been impressed with the bounty and generosity of Nature and the alleged inexhaustibility of her resources. "Thinking is difficult", said Goethe, "and acting according to reason is irksome." It seems to be hard for man to realize that no resource of Nature, not even the soil, the water, or the fishes of the sea, is inexhaustible.

A number of our valuable wildlife resources have been lost already. Some of the greatest concentrations have been lost already. Some of the greatest concentrations of the passenger pigeon on the American continent were found in the northern part of our region along the Ohio River. Shooting for the market, combined with the colonial habit of the birds during the nesting season which made them peculiarly vulnerable, brought about their extinction. During the last century, the Attwater prairie chicken has been extirpated from more than 93 percent of its former range along the coast of Texas and its numbers are now estimated to be less than one percent of those of a hundred years ago. A few greater prairie chickens are still to be found in northeastern Oklahoma. This splendid game bird formerly ranged rather widely over this State and neighboring parts of Texas. It is more than 40 years since the last flock of Carolina paroquets was seen in the wild. The Texas grizzly has been shot out. The trumpeter swan is gone from our area and only a few hundred birds exist anywhere. The ivory-billed woodpecker is now represented by carefully guarded remnants threatened with early extinction. Everyone knows the story of the buffalo. The elk has gone as a native inhabitant, although it has been reintroduced in Virginia and Texas. And where are the lesser and greater prairie chicken, the sharp-tailed grouse, the ruffed grouse, the sage hen that used to range into our territory?

To allow an abundant and valuable species of wildlife to become scarce is unwise. The costs of production of such wild species are negligible. Furthermore, the game life is regarded as the property of the whole people of the State, consequently no taxes have to be paid on it. Except for occasional damage to growing crops or otherwise, landowner income from wildlife, direct or indirect, is nearly all pure "velvet".

It is even worse to permit a species of wildlife to become extinct. Such instances of loss through default show that man is still a careless, blundering ignoramus in handling his natural resources. The loss of a fine game bird like the passenger pigeon was unnecessary and inexcusable. Destruction by vandals of a city, characterized for its fine buildings and noble works of art, is universally condemned. To a certain degree it is possible to rebuild a city, but a wild species, permitted to become extinct, is gone forever. Loss of wildlife means permanent impoverishment of the whole world culturally, artistically, and economically.

## Causes of Decrease

It will have been apparent already that the decrease of wildlife is the direct or indirect result of the activities of man. While the entirely proper occupation of the land for agriculture in its various phases accounts for a good deal of the decline, it must be conceded that carelessness, thoughtlessness, greed, and downright unintelligent exploitation have played altogether too large a part in the process. In all too many instances, man has ruined or befouled his environment and made it relatively less fit for his own habitation and enjoyment.

Wildlife decrease often is associated with exploitation in other provinces of Nature. Soil depletion, range exhaustion, deforestation, wastage and pollution of water resources, all take their sinister toll.

If present trends continue man may look forward to a much poorer world, infinitely less able to support human life. The immense economic value of the many branches of the wildlife industry would be permanently lost, and, perhaps more important than that, the beauty and attractiveness of man's friends and brothers in feathers, fur, and scales would be absent. The "age of rats and mice" would then come on the stage.

If, however, man can stem the tide of ignorance and greed; if he can speed up the processes of construction and conservation, he can anticipate a future age of peace, security, and happiness. Man is indeed the ruler of creation, and he has the power, with such resources as remain, to erect an empire of well-being for all. Research and intelligent application will not replace the minerals, the vanished species, the depleted soils, that are gone already; but they will make possible the proper use of such non-renewable and renewable riches as still remain. If man will but study and work unselfishly he can build up his soils, improve his grazing ranges, conserve and purify his supplies of life-giving water, save and increase his forests, augment his wildlife. In this way, and only in this way, can he realize those standards of human health, vitality, prosperity, and welfare which are his proper portion.

## Food Habits of Wild Geese Along the Texas Gulf Coast*

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### INTRODUCTION

Investigation of goose food habits by the writer began in 1939 and terminated in 1944, with most of the work being completed by the winter of 1942. While some work was done all along the coastal country, that portion from Corpus Christi to Galveston Bay was more thoroughly covered. Consequently, the material submitted is held to be representative of existing conditions from Brownsville to the Louisiana border, and extending inland from 30 to 60 miles. Cattle grazing is the principal land use for the area involved, followed by farming of cotton, grain sorghums, rice, corn, and a variety of truck farms.

Native vegetation of the coastal country runs largely to grasses, with associated weeds and some scattered timber. Immediately inland from tidewater along most of the coast, there are marsh and salt grasses. Next inland, the coastal prairie supports various species of *Andropogon*, *Paspalum*, *Sporobolus*, and *Panicum*, together with less common species. From Refugio to Nueces Bay there is a sparse brush plain that gives way in turn southward to a heavy brush belt reaching down to Willacy County and the Rio Grande Valley.

According to Frederick C. Lincoln of the Fish and Wildlife Service, and to census figures accumulated by the writer, Texas each winter has a population of approximately 300,000 wild geese. Of this number, by far most are to be found along the designated coastal range. These birds consist of the following species, Canada goose *(Branta canadensis canadensis)*, lesser Canada goose *(Branta canadensis leucopareia)*, Hutchins goose *(Branta canadensis hutchinsi)*, lesser snow goose *(Chen hyperborea hyperborea)*, blue goose *(Chen caerulescens)*, and white-fronted goose *(Anser albifrons albifrons)*. First flights of geese arrive along the coast during the last two weeks of September, with the heaviest movement usually coming in the first two weeks of October. Departures for the north commonly begin in March and may not cease until mid-May.

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*From a thesis submitted at Agricultural and Mechanical College of Texas, College Station, Texas.

## METHODS AND MATERIALS

Food matter from 117 goose gizzards was separated, measured volumetrically, and identified to furnish quantitative data. These gizzards came from the area between Corpus Christi and Galveston and represented collections from October to March for 1939 to 1942. Careful and extended field observations on goose feeding grounds and numerous interviews with residents of the winter range afforded further information. Also, great numbers of goose droppings were examined in an effort to keep a positive correlation between field and laboratory work on the problem.

## FIELD OBSERVATIONS ON FEEDING

Under normal circumstances, geese follow quite regular daily feeding schedules. When exposed to extreme hunting pressure or other severe disturbance they may become irregular to the extent of feeding at night and resting by day. Commonly, the *Branta canadensis* group begins leaving roosting grounds about a half hour before daybreak, and are all gone by an hour after sunrise. The lesser snow goose, on the contrary is the last to take flight, and most of them leave "en masse". On dark or overcast mornings the flight is delayed slightly.

Morning feeding, commonly done at distances up to 30 miles from the roost site, continues to midmorning, and then the birds begin flying to some waterhole to drink. The watering period may extent up to midafternoon, and then the afternoon feeding commences and continues until dark. Snow geese frequently remain on the feeding ground until after dark, whereas other species seldom are found out so late.

Rice unquestionably supplies more food for geese than does any other cultivated crop along the Texas coast. Within the rice belt, from Lavaca Bay to Louisiana, snow, blue, and white-fronted geese in particular take advantage of the enormous amount of shattered grain in stubble land. The writer found lesser Canada geese on rice stubble in Matagorda County on November 1, 1940, and Buster Chamblee of Oyster Lake, Matagorda County, states that Canada geese made their appearance in rice fields late in December of that year. They are reported also to feed some on rice in Chambers County, but all those observed in Wharton and Colorado counties were in pastures.

Shattered rice remains available to geese all winter, and there is no indication that sprouting of the grains make them any less desirable as food. When rains fall, buried rice is uncovered by erosive action and adds to the supply. However even half-buried grains are taken in great quantities, along with much soil. Frequently, birds were found to have taken almost as much soil as grain.

Corn is the favorite cultivated food of the *Branta canadensis* group, and it is taken extensively by the other species. The section of country from Lavaca Bay southward to Kleberg County produces sufficient corn each year to provide for the geese that winter there. Harvesting causes some shattering of corn in the fields, but most of the food left for geese consists of entire ears or small "nubbins" overlooked or dropped from wagons. As soon as corn stalks have been knocked down or the land plowed, geese move into feed. Exposed grains are eaten first, then ears with tips showing are pulled from the ground and shredded. Cultivation of corn land ends its usefulness to geese by January or a little later, and geese must shift to other food.

While grain sorghums are grown more extensively over the coastal goose range than either rice or corn, geese do not feed on these varieties to the extent that do the latter. In localities where either rice or corn occur, few if any geese are found in sorghum fields. However, in communities where their favored species are lacking, sorghum fields will draw geese if the grain production has been heavy. An increase along this line is evident throughout Nueces County, in particular. As yet, the writer has to find geese doing any feeding on standing sorghum, and it is seldom that they find shocked grain in the fields.

A few other crops afford smaller amounts of food for geese. Flax, a recent arrival in the blackland portion of the coastal country, attracts considerable numbers of Canada and lesser Canada geese for a short time in the late winter, but no other species has been observed feeding on it. In January 1941, near Austwell, geese clipped four inches from 70 acres of flax belonging to Frazier Brothers. This was done in three nights, leaving short stubs of the plant stems. All species of geese have been known to feed on leafy winter truck crops, mostly spinach and cabbage, but the acreage involved is small. Sudan and Rhodes grasses, hay and pasture crops, have been utilized in a few instances, and so have small grains planted for winter pasture. In the winter of 1944-1945, R. G. Smith of Rio Hondo, and others of the locality, had considerable goose feeding on English peas.

With regard to their habits in feeding on native vegetation, geese fall into two groups commonly referred to as "grazers" and "grubbers". In grazing, geese may take only a part of the foliage from plants, or they may strip the tender stem, seed heads, or flowers indiscriminately, frequently uprooting and eating entire plants of small species. Grubbing refers to the tearing out of tubers, rhizomes, and other underground parts of plants that grow in wet marsh land. A goose plunges its beak into the mud around the base of a plant and pulls up anything it can grasp. This is continued until a whole plant has been torn from the ground, and often until all plants are removed from the feeding spot.

Snow and blue geese, customarily frequenting marsh areas, are chiefly grubbers although they do a certain amount of grazing both in marshes and on prairies. The *Branta canadensis* group and white-fronted geese, in contrast, feed almost entirely by grazing. However, W. D. Bickford of Refugio County reports having seen these species follow along after grubbers in Guadalupe River marshes and picking up fragments which they had dropped. While the grazing species feed largely on open prairie country, they also clip considerable quantities of marsh vegetation at times.

Along the shores of San Antonio Bay, Aransas and Refugio Counties, the writer found geese feeding on stands of saltgrass *(Distichlis spicata)*, sea ox-eye *(Borrichia frutescens)*, cranberry *(Lycium berlandeiri)*, and smooth cordgrass. In March 1940, at a Bermuda grass sodded feeding-resting site on the Aransas National Wildlife Refuge, more than 300 Canada geese were flushed. The Bermuda grass *(Cynodon dactylon)* over the entire flat showed unmistakable signs of heavy grazing and there were goose droppings in abundance, investigation of which proved them to contain foliage and inflorescences of Bermuda grass. Daniel W. Lay reports that in Chambers County Canada geese feed chiefly on flats sodded over by Bermuda grass subsequent to overgrazing, also that hyssop *(Bacopa* sp.) and *Paspalum* sp. on near-by flats are taken. Up to the time that the Brownsville Ship Channel was excavated, Charles G. Jones observed flocks of the *Branta canadensis* group each fall feeding on cranberries growing in profusion over low, saline flats between Brownsville and Port Isabel, Cameron County. Following the channel excavation, however, cranberries began dying out and geese ceased to appear. At different times in 1939 the writer observed geese feeding in pure stands of glasswort *(Salicornia bigelovii)*, and salt cedar grass *(Monanthochloa littoralis)*. In 1942, others were seen to take bur clover *(Medicago hispida)*, evening primrose *(Oenothera speciosa)*, ragweed *(Ambrosia psilostachya)*, and wild verbena *(Verbena* sp.). O. F. Hartmann of Refugio County reports that he has seen geese feed on tallow weed *(Plantago* sp.) until their gullets were greatly distended, at which time the birds would finally fly off to secure water. He also states that geese on his farm have consistently stripped leaves from thistle *(Cirsium* sp.), with never any damage to seed or flower stalks.

Observations of snow and blue geese in marsh areas of Aransas, Calhoun, and Refugio Counties reveal that they feed on reeds *(Phragmites communis)*, salt grass *(Distichlis spicata)*, smooth cordgrass *(Spartina alterniflora)*, sacahuiste *(Spartina spartinae)*, bulrush *(Scirpus americanus* and *Scirpus robustus)*, cattail *(Typha angustifolia)*, smartweed *(Polygonum* sp.), and sedges *(Carex* sp. and *Cyperus* sp.). Upland feeding of the grubbing species was observed mostly in wet weather. In prairie pastures of Calhoun, Jackson, Goliad, Matagorda, and Refugio Counties the writer found great flocks of snow and blue geese in the period from January to March 1941. Vegetation available at the time included *Andropogon* spp., *Paspalum* spp., *Festuca* spp., *Eragrostis* spp., *Panicum* spp., *Setaria* spp., and *Sporobolus* spp. While considerable quantities of clovers, mustards, chickweeds, and parsleys were also present, grasses were taken almost exclusively by the geese in question.

## LABORATORY ANALYSIS OF GOOSE FOODS

In view of the sources of goose specimens and the various food materials involved, the writer made two divisions, one for specimens taken from the rice belt consisting of Brazoria, Colorado, Wharton, and Matagorda Counties, and the other from a general farming section including Aransas, Calhoun, and Refugio Counties. Furthermore, food apparently varied more with the district inhabited than with the goose species concerned, all species were placed together within each district group, respectively.

Identification of food materials, and the respective percentages found, are given in Tables I and II. Given, also are numbers of geese involved.

TABLE I

FOOD OF GEESE IN THE RICE BELT*

| Food Items | | Volumetric Percentage of Composition |
|---|---|---|
| Scientific Name | Common Name | |
| *Oryza sativa* | Rice | 96.00 |
| *Cynodon dactylon* | Bermuda grass | 2.74 |
| | Alga | .81 |
| *Medicago hispida* | Bur clover | .28 |
| Undetermined materials | | .14 |

*Goose specimens included in this analysis:

| | |
|---|---|
| Lesser snow goose | 8 |
| White-fronted goose | 6 |
| Blue goose | 4 |
| Canada goose | 3 |
| Lesser Canada goose | 1 |
| Total specimens | 22 |

Vegetable matter constituted 100 per cent of the food material examined. Among species from the rice belt, snow, blue, and white-fronted geese had eaten rice exclusively. One Canada goose had some rice, but others of that species had taken Bermuda grass, bur clover, and alga. Total esophageal contents of some white-fronted and snow geese ran as high as 75 and 80 C. C.

Geese taken from the other coastal section (Table II) not only utilized a greater number of plant species, but displayed a wide difference in the relative consumption of native and cultivated foods. Corn was the principal single item, taken more or less by all species. Although it was impossible to determine exactly the identity of about 40 per cent of the food material, grasses definitely constituted most of that amount. Canada geese, ranging over a more varied habitat than other species, had taken 64.71 percent of undetermined material.

Parts of plants eaten by geese are indicated in Table III. These are plant parts found either in droppings or gizzards. Other parts may have been overlooked because of a quicker breakdown in passing along the digestive tract. In addition to these findings, Daniel W. Lay informs the writer that in Chambers and Jefferson Counties members of the *Branta canadensis* group had been known to feed

### TABLE II

### FOOD OF GEESE IN THE GENERAL FARMING DISTRICTS*

| Food Items | | Volumetric Percentage of Composition |
|---|---|---|
| Scientific Name | Common Name | |
| *Zea mays* | Corn | 13.72 |
| *Distichlis spicata* | Saltgrass | 11.63 |
| *Sorghum vulgare* | Grain sorghum | 6.77 |
| *Radicula nasturtium-aquaticum* | Water cress | 5.86 |
| *Linum usitatissimum* | Flax | 3.51 |
| *Spartina spartinae* | Cordgrass (Sacahuiste) | 3.27 |
| *Panicum spp* | Panic grasses | 2.50 |
| *Rumex acetosella* | Dock | 1.87 |
| *Bacopa monniera* | Water hyssop | 1.67 |
| *Lathyrus pusillus* | Everlasting pea | 1.09 |
| *Paspalum spp* | Bull grasses | 1.03 |
| *Cynodon dactylon* | Bermuda grass | .80 |
| *Heliotropium indicum* | Heliotrope | .78 |
| | Alga | .68 |
| *Chaerophyllum spp* | Chaerophyllum | .64 |
| *Polygonum spp* | Smartweed | .47 |
| *Cynosciadium sp* | Wild parsley | .43 |
| *Sorghum halepense* | Johnson grass | .40 |
| *Ipomea spp* | Tie-vine | .34 |
| *Ambrosia psilostachya* | Ragweed | .31 |
| *Cucumis melo* | Wild cantaloupe | .30 |
| *Cyperus sp* | Nut grass | .28 |
| *Echinochloa colonum* | Wild millet | .23 |
| *Oxalis sp* | Sorrel | .15 |
| *Chloris spp* | Finger grass | .12 |
| *Sporobolus sp* | Smut grass | .12 |
| *Iva frutescens* | Marsh elder | .12 |
| *Diodia teres* | Poor Joe | .12 |
| *Geranium sp* | Geranium | .12 |
| *Medicago hispida* | Bur clover | .11 |
| *Corydalis sp* | Corydalis | .10 |
| *Graminae* | Unidentified grasses | 32.00 |
| Other unidentified matter | | 8.14 |

*Goose specimens included in this analysis:

| | |
|---|---|
| Lesser Canada and Hutchins geese | 55 |
| Canada goose | 12 |
| Lesser snow goose | 14 |
| White-fronted goose | 12 |
| Blue goose | 2 |
| Total number goose specimens | 95 |

on leaves of *Juncus* sp., foliage and inflorescences of Bermuda grass, and rice grain. Snow geese in the same locality had taken rhizomes of *Distichlis spicata*, *Scirpus robustus*, and *Juncus* sp., tubers of *Eleocharis quadrangulata*, and rice grain.

## SUMMARY AND CONCLUSIONS

1. Wintering geese ordinarily observe a regular daily feeding schedule, making one trip to feeding grounds in the early morning

and another in the late afternoon, the two being spaced by a midday rest period at a waterhole.

2. Food materials from 117 goose specimens proved to be entirely plant matter, including 31 species of flowering plants and one alga.

TABLE III

PLANT PARTS EATEN BY GEESE

| Scientific Name | Common Name | Parts Eaten |
|---|---|---|
| *Oryza sativa* | Rice | Seeds |
| *Zea mays* | Corn | Seeds |
| *Sorghum vulgare* | Grain sorghum | Seeds |
| *Distichlis spicata* | Saltgrass | Seeds, blades, and stems |
| *Radicula nasturtium-aquaticum* | Water cress | Foliage and stems |
| *Linum usitatissimum* | Cultivated flax | Foliage and stems |
| *Spartina spartinae* | Cordgrass (Sacahuiste) | Succulent sprouts, seeds |
| *Panicum spp* | Panic grasses | Seeds, blades and stems |
| *Rumex acetosella* | Dock | Seeds and foliage |
| *Bacopa monniera* | Hyssop | Foliage and stems |
| *Lathyrus pusillus* | Everlasting pea | Foliage and stems |
| *Paspalum spp* | Bull grasses | Seeds, blades, and stems |
| *Cynodon dactylon* | Bermuda grass | Seeds, blades, stems, and inflorescences |
| *Heliotropium indicum* | Heliotrope | Seeds and foliage |
|  | Alga | Filaments |
| *Chaerophyllum spp* | Wild carrot | Foliage and stems |
| *Polygonum spp* | Smartweed | Seeds (Achenes) |
| *Cynosciadium sp* | Wild parsley | Foliage and stems |
| *Sorghum halepense* | Johnson grass | Seeds |
| *Ipomea spp* | Tie-vine | Seeds |
| *Ambrosia psilostachya* | Ragweed | Foliage |
| *Cucumis melo* | Wild cantalopue | Seeds |
| *Echinochloa colonum* | Wild millet | Seeds |
| *Oxalis sp* | Sorrel | Foliage |
| *Chloris spp* | Finger grasses | Seeds and blades |
| *Sporobolus sp* | Smut grass | Seeds and blades |
| *Iva frutescens* | Marsh elder | Seeds and foliage |
| *Diodia teres* | Poor Joe | Seeds and foliage |
| *Geranium sp* | Geranium | Foliage |
| *Medicago dispida* | Bur clover | Foliage |
| *Corydalis sp* | Corydalis | Foliage |

3. More than 66 percent of the identified material was from the grass family *(Graminae)*.

4. Rice, corn, and grain sorghums were the cultivated crops most commonly and extensively taken by geese, and practically all the grain so taken was waste that they picked from the ground.

5. Saltgrass, water cress, cordgrass, panic grasses, and Bermuda grass were the native plant species most extensively consumed.
6. Succulent winter crops of flax and winter truck are sometimes taken by geese and may eventually require protection at times.

## Bobwhite Food Relations to Land Use in Northcentral Oklahoma

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During the years 1939-1944 a study was conducted to determine the relationships between land use and fall and winter foods of the bobwhite quail *(Colinus virginianus)* in northcentral Oklahoma.

The study was concentrated on an area of approximately 600 acres located in the Lake Carl Blackwell Project in Payne and Noble Counties. However, additional data on bobwhite food habits was obtained from farms in Payne, Lincoln, and Logan Counties. The vegetation, topography and general land use of this area has been described in a previous paper (Baumgartner, 1945).

The information on food habits was obtained by an analysis of the contents of crops of birds shot during the period from October to early April. Methods of analysis and compilation followed those described by Davidson (1940). Additional information on the feeding habits of bobwhite was obtained by watching the birds feeding or by signs of feeding chiefly during periods when the ground was covered with snow. The relationships between bobwhite distribution and land use were determined by intensive studies of the available food in regularly occupied winter ranges on the Lake Carl Blackwell Project plus general observations on farm lands throughout the study area.

### FALL FOODS ON THE LAKE CARL BLACKWELL AREA

On the basis of analysis of 168 crops the 19 most important fall foods (October-December) on the Project area are shown in Table 1. The volume of each of the other food species eaten was less than one per cent and the frequency of occurrence was correspondingly low. The table reveals that the sunflowers, chiefly *Helianthus annuus*, provided the food eaten most commonly in 1939 and in 1943 and on the average for the five years definitely outranked all other food species both from the standpoint of amount eaten and frequency of occurrence. The ragweeds, principally *Ambrosia psilostachya*, ranked second in volume and fourth in frequency of occurrence. The trailing wild bean, *Strophostyles helveola*, ranked as high as the ragweeds when the rank of their volume and frequency were added together. The pink wild bean, *Strophostyles umbellata*, was also a very important bobwhite food. The grain sorghums, *Sorghum vulgare*, ranked fourth in volume but thirteenth in frequency. Undoubtedly the grain sorghums would have ranked higher if this species had been available every year. However, in three out of the five years grain sorghums were not available either in food patches or in farm fields adjoining the study area. The other species were utilized in lesser volume or more infrequently.

## FALL FOODS ON FARMS

The food eaten by 37 bobwhite shot on farms is shown in Table 1.

### TABLE 1.

### IMPORTANT FALL FOODS OF THE BOBWHITE IN NORTHCENTRAL OKLAHOMA

**On the Lake Carl Blackwell Project (168 crops)**

| Food Item | Per cent by Volume | Per cent by Frequency |
|---|---|---|
| 1. Sunflowers (*Helianthus annuus et al.*) | 34.19 | 54.17 |
| 2. Ragweeds (*Ambrosia psilostachya* and *artemisiifolia*) | 11.02 | 33.33 |
| 3. Trailing wild bean (*Strophostyles helveola*) | 9.23 | 36.90 |
| 4. Pink wild bean (*Strophostyles umbellata*) | 5.96 | 24.40 |
| 5. Grain sorghums (*Sorghum vulgare*) | 5.82 | 6.55 |
| 6. False climbing buckwheat (*Polygonum scandens*) | 3.02 | 8.33 |
| 7. Wooly buckthorn (*Bumelia lanuginosa*) | 2.62 | 11.90 |
| 8. Ash (*Fraxinus sp.*) | 2.56 | 3.57 |
| 9. Hackberry (*Celtis sp.*) | 2.55 | 12.50 |
| 10. Johnson grass (*Sorghum halepensis*) | 2.52 | 8.33 |
| 11. Snow-on-the-mountain (*Euphorbia marginata*) | 2.48 | 16.07 |
| 12. Panic frasses (*Panicum dichotomiflorum et al.*) | 2.27 | 22.29 |
| 13. Sumacs (*Rhus glabra* and *copallina*) | 2.14 | 12.50 |
| 14. Rosin-weed (*Applopappus ciliatus*) | 1.85 | 20.24 |
| 15. Day-flower (*Commelina communis*) | 1.80 | 5.95 |
| 16. Oaks (*Quercus marilanica et al.*) | 1.79 | 3.57 |
| 17. Green vegetation | 1.59 | 45.24 |
| 18. Giant ragweed (*Ambrosia trifida*) | 1.51 | 10.71 |
| 19. Insects and other animal matter | .95 | 44.04 |

**On Farms (37 crops)**

| Food Item | Per Cent by Volume | Per Cent by Frequency |
|---|---|---|
| 1. Grain sorghums (*Sorghum vulgare*) | 25.35 | 43.24 |
| 2. Sunflowers (*Helianthus annuus et al.*) | 18.59 | 62.16 |
| 3. Oaks (*Quercus marilandica et al.*) | 13.54 | 16.21 |
| 4. Corn (*Zea mays*) | 9.38 | 32.43 |
| 5. Trailing wild bean (*Strophostyles helveola*) | 6.81 | 21.62 |
| 6. Ragweeds (*Ambrosia spp.*) | 4.76 | 29.73 |
| 7. Crotons (*Croton spp.*) | 4.19 | 27.02 |
| 8. Wheat (*Triticum aestivum*) | 2.59 | 16.21 |
| 9. Insects and other animal matter | 2.43 | 35.13 |
| 10. Johnson grass (*Sorghum halepensis*) | 2.05 | 27.02 |
| 11. Sumacs (*Rhus glabra* and *copallina*) | 1.81 | 5.40 |
| 12. Paspalum grasses (*Paspalum stramineum et al.*) | 1.76 | 13.51 |
| 13. Giant ragweed (*Ambrosia trifida*) | 1.62 | 18.92 |
| 14. Day-flower (*Commelina communis*) | 1.51 | 10.81 |
| 15. Wild grapes (*Vitis spp.*) | .89 | 16.21 |
| 16. Crab grass (*Digitaria sanguinalis*) | .89 | 13.51 |
| 17. Partridge pea (*Cassia chaemacrista*) | .81 | 5.40 |

The series is probably inadequate to show the relative importance of some of the species but the preponderance of certain species is considered significant. When compared with the Lake Carl Blackwell material the greater utilization of grains is quite conspicuous. The relative high position of acorns can be explained by the fact that these species were limited in abundance and distribution on the Lake Carl Blackwell study area. During two of the six years there was a heavy crop of acorns in northcentral Oklahoma. In the other four acorn production was poor. The frequent failure of the acorn crop makes this species an undependable source of food and undoubtedly has a marked effect upon the carrying capacity of many areas for bobwhite. The relative high position of the sunflowers, ragweeds and the wild beans, both on typical farm land and on the Lake Carl Blackwell Project, is considered sufficient basis for rating these plants to be of outstanding importance both on abandoned and occupied farms. Both groups are widely distributed and bear a heavy seed crop practically every year. The other species listed are unquestionably of considerable importance to certain bobwhite coveys but it is doubtful that they are absolutely essential to many coveys. The sumacs are an exception to this rule since field observations plus crop analyses have indicated definitely that most coveys feed chiefly on sumac berries during periods when snow covers the ground to a depth of several inches or more.

## WINTER FOODS ON THE LAKE CARL BLACKWELL PROJECT

During the months of February, March and the first week of April 24 crops were obtained. The major food items eaten by these birds is compared with those for the fall season in Table 2. The limited number of bobwhite meals represented unquestionably limits the value of the winter material. It is probable that the relative rank of some of the species would be quite different and a number of other species would have been of equal or greater importance if a larger series of crops had been available. Furthermore a considerable number of the birds were shot during periods of snow when sumac berries are the chief food item. Undoubtedly the high rank of the sumacs would not be retained in a large series of crops collected in all types of winter weather. The comparative low rank of the sunflowers and the ragweeds is to be expected since these species are relished by most kinds of seed-eating birds and many small mammals and are more or less completely consumed long before the end of the winter. These species are apparently supplanted by the legumes such as the wild beans, partridge peas, psoraleas and the bush clovers.

## EFFECTS OF LAND USE ON BOBWHITE FOODS

Decided changes in the relative importance of certain bobwhite foods occurred during the five year period of study on the Lake Carl Blackwell Area. These changes were caused in part by plant succession on land lying out of cultivation but also were affected by fires and grazing.

For example, in 1939 the common sunflower was the most conspicuous food plant on the abandoned fields that were last cultivated in 1938. One bottom land field of approximately 100 acres bordered by timbered ravines and ungrazed pastures supported a quail population having a density of a bird to the acre in the fall of 1939.

## TABLE 2.

## IMPORTANT FALL AND WINTER FOODS OF THE BOBWHITE ON THE LAKE CARL BLACKWELL PROJECT

### Fall Foods (168 crops)

| Food Item | Per Cent by Volume | Per Cent by Frequency |
|---|---|---|
| 1. Sunflowers (*Helianthus annuus et al.*) | 34.19 | 54.17 |
| 2. Ragweeds (*Ambrosia psilostachya* and *artemisiifolia*) | 11.02 | 33.33 |
| 3. Trailing wild bean (*Strophostyles helveola*) | 9.23 | 36.90 |
| 4. Pink wild bean (*Strophostyles umbellata*) | 5.96 | 24.40 |
| 5. Grain sorghums (*Sorghum vulgare*) | 5.82 | 6.55 |
| 6. False climbing buckwheat (*Polygonum scandens*) | 3.02 | 8.33 |
| 7. Wooly buckthorn (*Bumelia lanuginosa*) | 2.62 | 11.90 |
| 8. Ash (*Fraxinus sp.*) | 2.56 | 3.57 |
| 9. Hackberry (*Celtis sp.*) | 2.55 | 12.50 |
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| 11. Snow-on-the-mountain (*Euphorbia marginata*) | 2.48 | 16.07 |
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| 13. Sumacs (*Rhus glabra* and *copallina*) | 2.14 | 12.50 |
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| 15. Day-flower (*Commelina communis*) | 1.80 | 5.95 |
| 16. Oaks (*Quercus marilanica et al.*) | 1.79 | 3.57 |
| 17. Green vegetation | 1.59 | 45.24 |
| 18. Giant ragweed (*Ambrosia trifida*) | 1.51 | 10.71 |
| 19. Insects and other animal matter | .95 | 44.04 |

### Winter Foods (24 crops)

| Food Item | Per Cent by Volume | Per Cent by Frequency |
|---|---|---|
| 1. Trailing wild bean (*Strophostyles helveola*) | 41.38 | 45.83 |
| 2. Sumacs (*Rhus glabra* and *copallina*) | 22.25 | 37.50 |
| 3. Pink wild bean (*Strophostyles umbellata*) | 7.25 | 20.83 |
| 4. Partridge pea (*Cassia chaemacrista*) | 6.54 | 20.83 |
| 5. Few-flowered psoralea (*Psoralea tenuiflora*) | 6.00 | 20.83 |
| 6. Green vegetation | 4.29 | 60.00 |
| 7. Ragweeds (*Ambrosia psilostachya* and *artemissiifolia*) | 4.00 | 33.33 |
| 8. White avens (*Galium canadense*) | 2.50 | 4.17 |
| 9. False climbing buckwheat (*Polygonum scandens*) | 1.21 | 8.33 |
| 10. Paspalum grasses (*Paspalum stramineum et al.*) | .71 | 4.17 |
| 11. Sunflowers (*Helianthus annuus et al.*) | .58 | 12.50 |
| 12. Bush-clovers (*Lespedeza spp.*) | .54 | 8.33 |
| 13. Wild grapes (*Vitis spp.*) | .54 | 8.33 |
| 14. Thistle (*Cirsium sp.*) | .46 | 8.33 |
| 15. Broad-leaved spike-grass (*Uniola latifolia*) | .38 | 8.33 |
| 16. Capitate croton (*Croton capitata*) | .33 | 16.67 |
| 17. Tick trefoil (*Desmodium sp.*) | .29 | 8.33 |
| 18. Insects and other animal matter | .29 | 16.67 |
| 19. Wild peanut (*Amphicarpa bracteata*) | .25 | 8.33 |

Unfortunately for the bobwhite and many other species of seed-eating birds and mammals, sunflowers are usually superseded by rosin-weeds, *Applopappus ciliatus,* and annual grasses the second year after cultivation is stopped. This situation developed on the study area in 1940 and continued until 1943. The disappearance of sunflowers forced the birds to shift their feeding grounds to pastures and long abandoned fields where ragweeds and wild beans became the most important foods. The fact that the 1939 density of population was not equalled in succeeding years is believed significant. Dense stands of sunflowers apparently provide ideal fall habitats for bobwhite. In 1943 a combination of grazing and extensive fires set back the plant succession on the flats bordering intermittent stream beds and patches of sunflowers again became important fall feeding grounds.

As previously reported (Baumgartner, ibid.) fall and early winter fires on the Project destroyed the necessary winter food plants and forced bobwhite coveys to shift to new ranges. However, such fires apparently had little effect upon the carrying capacity of the range the next year. An extensive fire in late March of 1943 burned over all of the study area except for a few moist ravine bottoms. In addition to materially reducing the average density of the vegetation during the following fall and winter the fire also produced changes in the composition of the vegetation that had a marked effect upon the food supply of the bobwhite. For example snow-on-the-mountain, *Euphorbia marginata*, and rosin-weeds became conspicuous and widely distributed plants while the sumacs failed to produce fruit and the western ragweed did not bear as heavily as in previous years. A careful comparison of vegetative plots on the burned area with unburned sections of the Blackwell Project showed clearly that similar changes in the makeup of the vegetation had not occurred on the unburned areas.

Marked effects of moderate grazing upon bobwhite populations and food habits could not be discerned. In general moderate grazing appeared to cause some unstability in bobwhite populations particularly during the late winter when the birds apparently depended upon forage plants such as the legumes. However, no consistent depression of populations has been noted and no conspicuous changes in food habits have been determined.

The effects of heavy grazing upon bobwhite populations through the elimination of essential fall and winter foods were discussed in an earlier paper (Baumgartner, ibid.). Observations on an overgrazed section of the Lake Carl Blackwell Project were substantiated by census work on farm lands in the same locality. These data lead to the conclusion that prolonged overgrazing largely eliminates essential winter foods and causes a winter shifting of bobwhite ranges that is characterized by heavy losses from natural enemies and starvation or a combination of both.

## SUMMARY

A comparison of fall and winter bobwhite foods on abandoned and cultivated lands in northcentral Oklahoma yielded the following information:

1. The sunflowers, ragweeds, and the wild beans are the most important fall foods (October through December) on abandoned and idle farm lands.
2. On occupied farms, where cultivation is a major land use, the grains, particularly grain sorghums and corn, rank along with the sunflowers as preferred fall foods.
3. During the winter (January to April) the sumacs, the rag-

weeds and a number of species of wild legumes constitute important elements in the bobwhite diet.

4. Fall and winter fires destroyed the necessary winter food and evicted coveys from burned over ranges. A late winter fire caused noticeable changes in the food plants available for bobwhite during the following fall and winter seasons.

5. Moderate grazing apparently did not have an unfavorable effect upon bobwhite fall and winter food supplies. Heavy grazing destroyed many of the essential fall and winter foods and forced coveys to shift to new ranges before spring.

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# Flood Control Projects and Their Relation to Wildlife in Southeast Texas

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In the spring of 1945 the Lower Neches Valley Authority ceased making plans for the construction of the Rockland dam on the Neches River. Their plans were relinquished to the United States District Army Engineers after Senate Bill 98 was passed March 2, 1945. Senate Bill 98 is a flood control program for Southeast Texas. The plans of this bill include the construction of four dams. The Rockland Dam will be on the Neches River, and the McGee Dam will be on the Angelina River. Dam A and Dam B are to be small structures on the Neches below its confluence with the Angelina. An appropriation of $27,000,000 is expected in 1946 to develop these units.

The area to be inundated is covered with a mixed pine and hardwood forest. A conservative estimate reveals that 10,381,000 board feet of pine and 21,228,000 board feet of hardwood will be removed from the bed of these lakes before they are filled. The original estimate of the army engineers on the size of these lakes show that the Rockland reservoir is to cover 93,000 acres; McGee 130,000 acres; A dam 1,000; and B dam 11,000 acres. However, it is now considered on good authority that this estimate will be nearly 100,000 acres too much.

A considerable portion of the area to be flooded is ideal for deer, turkey, squirrel, and fur bearers. The squirrels will be affected more than any of the other species. The deer can easily become adjusted to suitable habitat surrounding the lake. The turkey population for the past several years on this area has been reduced to rumored sight records. The den trees and the numerous sloughs that form excellent feeding grounds for raccoon will be greatly reduced. The small population, no doubt, can become adjusted to the shoreline habitat. The number of acres of wildlife habitat eliminated by these lakes will not be important when the total potential acreage of wildlife areas in East Texas are considered.

The benefits derived from these bodies of impounded water will be many. Greater industrial development of the Beaumont and Port Arthur area is awaiting a more permanent supply of fresh water. The hydro-electric output of this program will be sufficient to supply 250,000 people or enough to operate the city of Port Arthur. The rice farming of the coastal region has been impaired in the past because salt water would come up the Neches River to the present irrigation canals and then would be pumped onto the fields of growing rice. From the new and improved irrigation system many other crops can be irrigated.

The problems of river bottom floods will be considerably reduced. With the menace of floods removed, livestock could be permitted to range in the bottomlands throughout the year. The regulated flow in the Neches River will make it navigable up to Dam B or about 60 miles farther inland than Beaumont. Industries requiring a large and permanent amount of fresh water to operate will be able to locate farther inland than ever before.

The wildlife and recreational facilities are mentioned in Senate Bill 98, but it is not specific as to the agency that will manage the wildlife and develop the recreational areas. By the construction of these lakes, boating, camping, fishing, and waterfowl hunting will be improved for East Texas. The agency that has the sporting facilities in charge should see that at least fifty percent of the shoreline is kept open for the general public to use. Construction of hunting and fishing camps for public use should be encouraged.

The following is quoted from Senate Document 98 as approved March 2, 1945: "The Rockland and McGee Reservoirs would have a combination surface area, at maximum draw-down, of about 100,000 acres. This large water area would be of value for boating, fishing and miscellaneous recreational purposes; and would afford a valuable sanctuary for wildlife. According to the estimate made by the executive secretary of the Texas Game, Fish and Oyster Commission, the recreational and wildlife conservation value of these lakes would amount to $45.00 per acre, or a total value of $4,500,000. Because of the large minimum surface area of the two lakes and the absence of such fresh water lakes in this vicinity it is believed that the recreational and wildlife conservation benefits would be $75,000 annually."

Even though some species of wildlife will suffer locally, the over-all problem of affording the sportsmen a place to hunt and fish will be relieved. More than 50 percent of one of the game department's deer and turkey refuges will be inundated. Probably more sportsmen will be served by the creation of this lake than ever would have been able to be served in hunting the overflow from deer, turkey, and squirrel.

In view of this fact that the new lakes will provide recreation for more people than the acreage-to-be-inundated is providing at present, we approve of the planned construction. However, it should be emphasized that reservoirs on other Texas rivers present different situations and are not all such definite benefits to the public from the standpoint of providing recreation. On the Colorado River where large lakes have been impounded there are already present more public fishing waters than are being used. Additional impoundments must be charged up as inundation of deer and turkey habitat with little compensation in the form of fishing.

On the Clear Fork of the Brazos the game department operates a turkey and deer refuge of 80,000 acres which includes about 30 miles of river bottom. The bottom is narrow but fertile and produces a strip of giant pecan trees. The surrounding country is mesquite grassland which offers little food or cover to game in winter. The turkey population of Throckmorton and Shackelford counties winters on the Clear Fork bottomlands. A proposed dam in that locality would deprive those two counties of one of the finest populations of native turkeys in the state and would add nothing to the fishing resources of the locality. Lake fishermen can go to near-by Possum Kingdom Lake. Many local fishermen prefer to fish for channel cats in the rapids and pools of the Clear Fork. This type of fishing would be out if dams and lakes were stair-stepped up the watershed.

So in summary, we feel the proposed developments of reservoirs on major rivers in East Texas are desirable because no such impoundments have yet been made in this section of the State. We expect, however, that these four lakes will be enough to balance the recreation assets of East Texas. Any proposal to stair-step reservoirs up the Neches or any other river in Texas should be weighed carefully against the loss of fertile river bottom soils and the need for additional fishing and waterfowl areas.

## Some Successful Methods of Clearing Impounded Waters of Turbidities Due to Silt

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Most impoundments in the Southwest and particularly those receiving water from clay soils develop high turbidities due to silt. The finer soil particles often remain in suspension permanently, forming a colloid. All impounded waters precipitate the larger particles and some show complete precipitation even in the clay soil areas.

In general there is an ecological succession from a highly productive condition to one of low productivity in Southwestern reservoirs. When first formed these reservoirs tend to produce excellent fish crops but decrease their productivity until they are poor fishing areas. This decreated productivity seems to coincide with an increased turbidity of the water, although the tendency of fish to over-reproduce also enters into the picture. New impoundments usually precipitate their colloidal soil during the early period of existence. Clear water permits light penetration necessary for plant growth and green plants are the basis of food for all animals (cattle, human or fish). As the turbidity of the water increases light penetration decreases until plant growth (rooted or algal form) is practically eliminated. In this way turbidity due to silt decreases the productivity of lake and pond waters.

Observations and experiments concerning the precipitation of colloidal soil particles from impounded waters of central Oklahoma (Irwin, 1945) revealed the following information:

1. Impoundments, large or small, that inundate large areas of vegetation when first formed precipitate their silt loads for the first year of their existence. Later, after the organic matter has disappeared, these impoundments may become permanently turbid from silt.

2. Ponds which receive runoff water from sizeable feeding lots or barnyards thus being supplied with considerable manure and urea come to have clear water year after year except for short periods during and following heavy rains.

3. Reservoirs in whose water submerged higher aquatic plants become well established during the period of clear water remain clear in like manner year after year.

4. A lake whose water has continued to clear year after year for 29 years became turbid and remained to when its well established submerged aquatic flowering plants were purposely removed.

5. All ponds that become choked with aquatic plants whether of the emerged or submerged types, have clear water as long as the plants are permitted to grow.

6. Ponds whose bottoms ar stripped of vegetation when being constructed have turbid water from the first.

7. Ponds that have been drained and excavated of their silt are always muddy when refilled unless some form of fertilizer is added.

8. Impoundments to which considerable vegetation was added bebecame clear in 4 to 14 days after treatment.

9. Waters to which manure was added became clear shortly after treatment.

10. Pond waters treated with sludge precipitated their colloidal soil particles.

11. Ponds which received regular treatments of commercial fertilizers containing superphosphate either cleared completely or decreased their turbidities appreciably. All ponds treated thusly for two years had clear water the second year.

12. Microscopic examination of the waters before and after treatments with vegetation showed decreased Brownian movements following treatment.

13. Waters cleared by the above treatments quickly dropped their soil again when stirred by wading and stomping, or when roiled by wading stock.

14. Some ponds with large watersheds once cleared by treatment failed to clear again after being flushed during heavy rains.

15. All ponds treated for two consecutive years required less

material the second than was needed the first year to produce clear water. Thus indicating that there is not a total loss but rather a gain in the affects of the materials added.

16. Physical and chemical analysis of pond waters treated with vegetation showed a marked increase in hydrogen-ion concentration and carbon dioxide content during the period of rapid decomposition and that during this period precipitation took place most readily.

17. It had been noted that the addition of small quantities of concentrated sulphuric acid to water samples caused rapid precipitation. The acid would ionize releasing positive (hydrogen) ions that would neutralize the negative charge on the soil particles allowing them to flocculate and precipitate.

From the results of these observations and experiments it was concluded that there was a relation between organic materials or commercial fertilizers and the precipitation of colloidal soil particles. Since *all* colloidal particles in water possess a negative charge, one could not assume the mere presence of suspended humus in the water would cause precipitation. Therefore the action must be a chemical one in which positive ions are released to neutralize the negative charges on the soil particles. Once liberated from their suspending force the particles coagulate and settle and do not readily become suspended again even when stirred by stock or waves.

Organic material added to the water could produce carbonic acid and probably tannic and humic acids which would ionize releasing positive charges to be available for neutralization. In like manner superphosphate provides a good buffer agent involving phosphoric acid. The continued presence of such a buffer or agent that ionizes in the water or causes other compounds to ionize would bring about a continued precipitation of silt in the water.

The amounts of the different materials per acre-foot of water necessary to settle the particles are difficult to determine. Impoundments vary in turbidities; one with a high turbidity will require more positive ions than one with a low turbidity. The type of material used in treatment might differ in its effectiveness from other types. Manure appears to produce more rapid and longer-lasting effects than does vegetation, and green vegetation produces more rapid results than the same material cured. Since the vegetation grown on the basin before flooding is generally sufficient to cause precipitation, it seems likely that the vegetation from an equal and comparable area would produce similar results.

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# Waterfowl Observations in the Texas Panhandle

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Nine months out of the year, the High Plains Region,[1] of which the Texas Panhandle is a part, ranks among the outstanding waterfowl areas of America. But despite its importance, this region is scarcely represented in the literature dealing with waterfowl. The following observations covering the period between September, 1942 and September, 1945, are presented to partially fill the void.

The Panhandle owes its prominence as a waterfowl area to its bee-line position between the northern breeding grounds and the coastal wintering marshes, its system of lakes, and its extensive sorghum and wheat fiields. Lincoln (1) summarized a description of the Central Flyway as follows: ". . . the majority of the ducks that use it make direct north and south journeys from breeding grounds in central Canada and other northern regions to their winter quarters, which are chiefly in Texas".

## HABITAT

The drainage system for the High Plains Region is unique. Run-off collects in depressions known as playa or wet-weather lakes. Based on data presented in various descriptions of the High Plains Region (2) (3) (4) (5) (6), the estimated number of such lake beds in the 26 counties of the Texas Panhandle is more than 6,000, averaging nearly 40 acres each, and covering a combined area of a quarter of a million acres.

Unfortunately for the ducks, the water area of the High Plains is very unstable. Nearly all of the depressions were flooded in 1941, but by 1945 only one per cent contained water. Rains of the High Plains are so erratic that they may fill a group of lakes, skip some, then fill another group. As one weatherman stated, "variations of 100 per cent in both total seasonal and total annual rainfall have been observed within distances of 4 or 5 miles" (7).

The amount of rain required to fill these lakes depends largely on the nature of the shower. A two-inch rain falling gently on parched soil has insufficient run-off to leave standing water. But at Dalhart in 1934, a fast-falling two-inch rain flooded 539 acres of a 40,000-acre tract to an average depth of 24 inches (8). Once filled, the lakes lose water through evaporation and percolation at the rate of from a tenth to four-tenths inches a day (9). Lakes may vanish suddenly because their bottoms are so level that ten or more acres may be covered to a maximum depth of only an inch. I have seen a strong wind remove that last inch within a few hours.

Most Panhandle lakes vary in size from five acres to a quarter-section, but a few natural lakes of the South Plains cover a section or more. Usually dependable sources of water, these lakes, like most of the playa lakes, were drouth casualities in 1945. The lakes of the Muleshoe National Wildlife Refuge were among those to go dry.

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[1] Included in the High Plains Region are parts of Nebraska, Colorado, Kansas, New Mexico and Oklahoma, as well as Texas.

Permanent lakes, all of which are artificial in this area, total about 5,000 acres and vary in size from 1800-acre Buffalo Lake to half-acre ponds created by stockmen. Even the permanent lakes are unstable in size and may shrink to half their potential area. Streams of the Panhandle include the Canadian River and its tributaries, the Red River and its tributaries, and the headwaters of the Brazos River. All are intermittent in flow during dry periods. Except for the mile-wide sand bars of the Canadian which are attractive to geese, the river channels are unimportant to waterfowl. But some of the tributaries have been dammed to form excellent lakes.

The only sizable swamp habitat suitable for wood ducks[2] in the Panhandle is found in the eastern part, along the Canadian bottoms where marshy hay meadows also occur. Blackwater Draw, a tributary of the Brazos, in Lamb County, is the only other marsh habitat of consequence.

Distributed over much of the High Plains area are huge fields of wheat and grain sorghums. The former is especially attractive to geese, the latter to ducks. Both are indispensable parts of the waterfowl habitat and both shrink or expand, depending on moisture conditions. Some autumns there is little or no wheat pasture for the geese, and only irrigated fields provide grain. Most of the lakes are poor sources of waterfowl food. Many are barren or have worthless weeds covering their bottoms. Occasionally they have excellent stands of smartweed or spike rush. A few of the permanent lakes have abundant growths of submerged aquatics, including horned, bushy, sago, and long-leaved pond-weeds and coontail.

The lakes and fields of the Plains are used by millions of waterfowl annually. I have seen gatherings of ducks at Buffalo Lake and Blackwater Draw that compare favorably with the greatest to be found in the Illinois Valley, long famous for its huge concentrations. The wintering goose population in 1945 at Buffalo Lake was undoubtedly one of the largest in America's interior.

## SUMMER AND FALL

The Panhandle is never without ducks. During the summer months, I have recorded fifteen species. One or more nesting records are available for the following species: pintail, blue-winged teal, mallard, gadwall, shoveler, wood duck, and ruddy duck. While no nests or broods of the cinnamon teal have been found to my knowledge, its behavior during the summer months stamps it as a nesting species. Pintails produced more young than all other species combined during the summer of 1943, through 1945, but still I should class them as uncommon breeders. Apparently the Panhandle is primarily a summer resort for nonbreeders, but if reports from local laymen are correct, fair numbers may nest in the area during wet springs.

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[2] There is a small area of flooded timber at Palo Duro Club in the Western Panhandle, where on July 11, 1943, I encountered a newly-hatched brood of wood ducks.

Late in July, the fall migration starts. First come the blue-winged teal and a few pintails. In mid-August pintails take the numerical lead and hold it until the big mallard push of mid-November. September brings green-winged teal, a few wood ducks, vanguards of gadwalls, baldpates, shovelers, red heads, ruddys and a fair flight of coots and white-fronted geese. By mid-October, mallards and canvasbacks appear, and most blue-wings disappear. Shortly thereafter, the first Canada geese arrive. With the opening of the hunting season in November comes the first flight of mallards. Ruddys depart. It is late November before the American mergansers and goldeneyes reach the Panhandle.

Until hunters' guns invade their solitude, playa lakes are the preferred resting grounds for ducks, but after the first volley, Buffalo Lake, which is a refuge, becomes the chief concentration point. From mid-November until the freeze-up, hordes of mallards, pintails and Canada geese compete for swimming space over most of Buffalo Lake's surface.

## FEEDING HABITS AND CROP DAMAGE

Myriads of waterfowl require tons of feed, most of which must be pilfered from farmers' sorghum fields. Starting before dawn, the morning duck flight usually returns to the resting grounds before sunrise. Shortly after sunrise the geese leave for the fields and remain there most of the morning. In the evening, the geese leave first, about a half hour before sunset and return as it is getting dark. A typical evening flight of ducks recorded in detail, started to leave for the fields 16 minutes after sunset. The interval between the first departure and the last was 18 minutes. Sixty per cent of those leaving had returned before it became too dark for further observation. An estimated forty per cent never left the lake, suggesting that while a flight goes to the fields twice daily, individual ducks may go only once. Only 16 minutes elapsed between the first departures and the first returns, indicating that the ducks wasted no time in feeding. Geese fed more leisurely than ducks, usually taking an hour or more between the first departures and first returns.

Feeding radii from Buffalo Lake extended at least 25 miles for ducks and 18 miles for geese. En route to distant fields the ducks and geese sometimes avoided equally productive fields for reasons not apparent to me.

Crop damage complaints frequently are exaggerated, but that much real damage occurs is indicated in the following analysis. It takes about 600 mallards or 900 pintails to eat a bushel of grain sorghum at a feeding. Thus, the quarter of a million ducks at Buffalo Lake in 1944-45, occurring in a ratio of 3 mallards to 2 pintails, consumed about 21,250 pounds of grain per meal, worth $425, at $2.00 per hundred, the current cost of grain sorghum. The actual cost to the farmer was somewhat less since some of the grain consumed had been wasted during the harvest, hence had no value to the farmer. Since these conditions lasted for almost 90 days, farmers within the 25-mile feeding radius of the lake lost several thousand dollars worth of grain. Damage estimates were deduced from 93 questionnaires returned by Panhandle farmers. Fifty-six per cent reported some crop damage due to ducks, geese or sandhill cranes.[3] Twelve percent claimed losses every year. The average loss per farmer who furnished figures was $330. Others told of damages amounting to several hundred dollars and from a tenth to half a crop. The net result: an antagonism toward waterfowl and cranes.

## FOWL CHOLERA

Opposition is never conducive to cooperation, yet waterfowl need farmer cooperation badly in combating a serious outbreak of fowl cholera. This contagious poultry disease killed at least 5,000 ducks and geese in the Texas Panhandle during the spring of 1945, and threatens to kill many more in the future unless preventive measures are put into effect (10). Fowl cholera is transmitted from domestic to wild fowl on their common feeding grounds in grainfields and around lakes close to the barnyard. Farmers aggravate the problem by disposing of diseased carcasses where their own flocks as well as wild fowl have access to them. To protect their own interests as well as waterfowl, Panhandle farmers must be familiarized with the hazards of fowl cholera and methods of control.

## HUNTING

Compared to the numbers present, few ducks are bagged by Panhandle hunters for the following reasons: playa lakes are difficult to hunt because of their shape, size, lack of cover and wide distribution. Hunters are not numerous enough to keep the ducks moving. Once shot at, ducks usually have no trouble finding a lake where they can rest unmolested. Few hunters make use of adequate blinds, decoys and other paraphernalia necessary for good results.

Success measured in terms of ducks bagged per average hunter per day, according to samples I have taken, varied from less than one on warm, calm days to nearly 7 on windy days. Limits were rare except at Palo Duro Club, Big Bull Ranch, Turkey Track Ranch and a few other places where the hunting was more or less organized and the hunters experienced. Annual kills up to 500 have been recorded at Palo Duro Club, an average of 4 ducks per acre. But for the Panhandle as a whole, it is doubtful whether the annual duck kill from 1942 through 1944 exceeded 10,000. A large part of this total was killed illegally by hunters who resorted to shooting the ducks in grainfields during unauthorized hours.

Possibly one duck per thousand that passed through the Panhandle was bagged by a hunter, but the lesser Canada goose kill ran as high as one out of ten. Goose hunters in 1944 were more numerous and more successful, at least in the Buffalo Lake area, than were duck hunters. From 1942 to 1944 the winter goose concentration at Buffalo Lake increased from 2,000 to 10,000. Hunters took to this new-found sport of goose hunting like a duck to water, and recruits have been added at an alarming rate. The 1944 goose kill was not far from 2,000, which puts Buffalo Lake in the higher brackets as a goose hunting area. There is a definite danger that the Buffalo Lake goose kill may get out of bounds, if it has not already done so.

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[3] Sandhill cranes are included in this discussion because they share crop damage responsibilities with the waterfowl. They are present in the Buffalo Lake area from late September into December in numbers up to 5,000. Even greater numbers are found in and around the Muleshoe National Wildlife Refuge, where they winter.

## BAG INSPECTION

Inspection of nearly a thousand ducks killed by hunters (Table 1) revealed that water conditions have a marked bearing on the kinds of ducks killed. In 1942, a wet year, two diving ducks were bagged for every three dabblers, but in 1943, a dry, the ratio of divers to dabblers was 1:4. In 1942 lesser scaups ranked first in the kill but tenth in 1943. During the same years, mallards jumped from seventh to first place, a change probably accountable to temperature. Warm weather in 1942 held mallards north of the Panhandle until a cold snap brought a through flight without the usual stop-over

TABLE 1.

CLASSIFICATION OF WATERFOWL BAGGED BY TEXAS PANHANDLE HUNTERS DURING 1942 AND 1943

| | 1942 | | | | | 1943 | | | | | Rank in Kill | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Juv. M | Ad. M | Juv. F | Ad. F | Total | Juv. M | Ad. M | Juv. F | Ad. F | Total | 1942 | 1943 |
| **Dabblers:** | | | | | | | | | | | | |
| Mallard | 10 | 12 | 9 | 6 | 37 | 16 | 18 | 14 | 10 | 58 | 7 | 1 |
| Pintail | 16 | 17 | 28 | 25 | 86 | 13 | 10 | 14 | 17 | 54 | 2 | 2 |
| Baldpate | 34 | 5 | 36 | 3 | 78 | 12 | 5 | 18 | 2 | 37 | 3 | 3 |
| Gadwall | 26 | 8 | 36 | 2 | 72 | 15 | 5 | 9 | 3 | 32 | 4 | 4 |
| Shoveler | 24 | 6 | 16 | 7 | 53 | 10 | 4 | 9 | 1 | 24 | 5 | 5 |
| Gr.-Winged Teal | 18 | 5 | 12 | 4 | 39 | 3 | 2 | 2 | 4 | 11 | 6 | 8 |
| Bl.-Winged Teal | .. | .. | .. | .. | 0 | .. | .. | 1 | .. | 1 | .. | 16 |
| Total Dabblers | 128 | 53 | 137 | 47 | 365 | 69 | 44 | 67 | 37 | 217 | ........... | |
| **Divers:** | | | | | | | | | | | | |
| Lesser Scaup | 67 | 1 | 58 | 1 | 127 | 3 | 0 | 1 | 0 | 4 | 1 | 10 |
| Ring-Necked Duck | 21 | 1 | 11 | 1 | 34 | 4 | 4 | 3 | 2 | 13 | 8 | 7 |
| Canvas Back | 12 | 0 | 14 | 2 | 28 | 5 | 1 | 3 | 0 | 9 | 9 | 9 |
| Bufflehead | 3 | 1 | 12 | 5 | 21 | 0 | 1 | 0 | 3 | 4 | 10 | 12 |
| Redhead | 6 | 3 | 9 | 1 | 19 | 4 | 3 | 10 | 2 | 19 | 11 | 6 |
| Greater Scaup | 2 | 0 | 3 | 0 | 5 | 1 | 0 | 0 | 0 | 1 | 12 | 15 |
| Ruddy | 2 | 0 | 1 | 0 | 3 | 1 | 0 | 3 | 0 | 5 | 13 | 11 |
| Goldeneye | 1 | 0 | 1 | 0 | 2 | 2 | 1 | 0 | 1 | 3 | 14 | 13 |
| A. Merganser | .. | .. | .. | .. | 0 | 0 | 0 | 2 | 0 | 2 | .. | 14 |
| Total Divers | 114 | 6 | 109 | 10 | 239 | 20 | 10 | 22 | 8 | 60 | ........... | |
| Total Ducks | 242 | 59 | 246 | 57 | 604 | .. | .. | .. | .. | 277 | ........... | |
| L. Canada Geese | 18 | 9 | 18 | 7 | 52 | 3 | 3 | 4 | 2 | 12 | ........... | |
| W. Swan | .. | .. | .. | .. | .. | Juv. (sex unknown) | | | | 1 | ........... | |

Key: Juv. Juvenile; Ad. Adult; M. Male; F. Female; A. American (Merganser); L. Lesser (Branta c. leucopareia); W. Whistling (Swan).

in the Amarillo area where most of the hunting occurs. During both 1942 and 1943 the kill of pintails, baldpates, gadwalls and shovelers ranked in that order below the leaders.

The sex ratio in pintails warrants further study. In the kill the sex ratio of 140 drakes and hens was 40:60; among 424 banded it was 60:40; in samples totaling nearly 2,000 birds in flight it was 53:47; and of 1,088 found dead from wounds or disease, drakes led hens 60:40. I am unable to explain the variations, but in the Panhandle, hens are more vulnerable to shooting than drakes, if the small sample of bagged birds inspected can be used as an indicator.

Both bag inspection and banding revealed that juvenile baldpates were more numerous than adults. The combined bag and trap ratio was 11:1. Either adult baldpates use a different route from the juveniles or suffer heavier losses before reaching the Panhandle. Since a similar unbalanced ratio occurs in Illinois, I suspect that the former is true. Ring-necked ducks and lesser scaups also exhibited an excess of juveniles. In 1942, among 161 scaups and ringnecks inspected, only four adults were found.

## BANDING

From a total of 739 banded ducks there were 51 returns (7 per cent) during the two hunting seasons following the banding (Table 2). Of 184 baldpates banded 9.2% were reported killed; of 424 pintails, the kill was 5.9%; of 84 mallards it was 3.6%. Sixty per cent of the returns were from Texas; forty per cent were from elsewhere (Table 3).

### TABLE 2.

### CLASSIFICATION OF 739 DUCKS BANDED* NEAR AMARILLO, TEXAS, BETWEEN SEPTEMBER 29 AND NOVEMBER 14, 1943

| | Juv. | Ad. | Juv. | Ad. | ? | Total | Total Re-trapped | % Re-peats | No. Re-turns | % Re-turns |
|---|---|---|---|---|---|---|---|---|---|---|
| | M | M | F | F | F | | | | | |
| Pintail | 232 | 23 | 129 | 40 | ..... | 424 | 50 | 11.7 | 25 | 5.9 |
| Baldpate | 86 | 3 | 88 | 7 | ..... | 184 | 68 | 37.1 | 17 | 9.2 |
| Mallard | 23 | 17 | 11 | ..... | 33 | 84 | 1 | 1.2 | 3 | 3.6 |
| Green-winged Teal | 7 | 3 | 15 | 8 | ..... | 33 | 4 | 12.1 | 2 | 6.0 |
| Blue-winged Teal | 4 | 0 | 1 | 1 | ..... | 6 | 0 | ....... | 0 | ....... |
| Gadwall | 3 | 0 | 2 | 0 | ..... | 5 | 1 | ....... | 2 | ....... |
| Redhead | 2 | 0 | 0 | 0 | ..... | 2 | 1 | ....... | 1 | ....... |
| Ring-Necked Duck | 0 | 0 | 0 | 1 | ..... | 1 | 1 | ....... | 1 | ....... |
| Total or Average | 357 | 46 | 246 | 57 | 33 | 739 | 126 | 17.0 | 51 | 6.9 |

Key: Juv. Juvenile; Ad. Adult; M. Male; F. Female; ? Female, age unknown.

Banding costs were $20.00 for 1,000 pounds of sorghum bait; $10 for transportation; $5.00 for wire and miscellaneous, or $.047 per duck banded.

Seventeen per cent of the banded ducks were re-trapped from one to six times (Table 4). The interval between the original banding date and the last retrap date for each repeater furnishes a clue to the length of time that bird remained at one place. All such records combined is a possible index to the population turnover rate. Forty per cent of the ducks remained at the banding station less than four days; 70 percent stayed less than a week; only 7 per cent remained more than two weeks (Table 5). How much the turn-over rate was influenced by my trapping activities I am unable to say, but since duck census figures are all but worthless without a knowledge of turn-over, it behooves waterfowl banders to study their repeat data carefully.

### TABLE 3.

### DISTRIBUTION OF BANDING RETURNS

| Place Killed | Pintail | Baldpate | Mallard | G. W. Teal | Gadwall | Redhead | Ringneck | Total |
|---|---|---|---|---|---|---|---|---|
| South America | 1 | | | | | | | 1 |
| Central America | 1 | | | | | | | 1 |
| Mexico | 3 | 1 | | | | | | 4 |
| Texas | 10 | 14 | 2 | 1 | 2 | 1 | 1 | 31 |
| California | 1 | 2 | | | | | | 3 |
| Louisiana | 1 | | | | | | | 1 |
| New Mexico | | | 1 | | | | | 1 |
| Nebraska | 1 | | | 1 | | | | 2 |
| Utah | 1 | | | | | | | 1 |
| Iowa | 2 | | | | | | | 2 |
| South Dakota | 2 | | | | | | | 2 |
| North Dakota | 2 | | | | | | | 2 |
| Total | 25 | 17 | 3 | 2 | 2 | 1 | 1 | 51 |

Note: In addition to returns from ducks banded near Amarillo I encountered the following returns from ducks banded elsewhere but killed in the Texas Panhandle: Killed in 1942, a mallard banded in 1938 at Wichita Mt. Refuge, Cache, Okla., and a pintail banded in 1940 at Avery Island, La. Killed in 1943: A pintail banded in 1937 at Liberal, Kansas, and a mallard banded in 1940 by Ducks Unlimited at Maple Creek, Saskatchewan.

### TABLE 4.

### NUMBER OF TIMES 126 DUCKS (17% OF 739 BANDED) WERE RETRAPPED

| Times Retrapped | 1 | 2 | 3 | 4 | 5 | 6 | Total |
|---|---|---|---|---|---|---|---|
| Number of Ducks | 70 | 32 | 11 | 9 | 5 | 2 | 126 |

### TABLE 5.

### INTERVAL IN DAYS BETWEEN THE INITIAL BANDING AND FINAL RETRAPPING OF 126 DUCKS

| Number of Days | 1-3 | 4-6 | 7-9 | 10-12 | 13-15 | 16-18 | 19-21 | 22-24 | Total |
|---|---|---|---|---|---|---|---|---|---|
| Number of Ducks | 50 | 37 | 14 | 8 | 8 | 5 | 3 | 1 | 126 |

## WINTER AND SPRING

The waterfowl chronology of the Panhandle is incomplete without a brief discussion of wintering and spring migration. Weather and the amount of water and feed available determine the number of waterfowl that winter in the Panhandle. Thus, the winter of 1944-45 was mild and feed was plentiful, so up to a half million ducks and 10,000 lesser Canada geese wintered in the Buffalo Lake area alone. Less favorable conditions during the two previous years had held the wintering population at Buffalo Lake to a tenth as many ducks and geese. In Lamb and Bailey Counties in the next tier of counties south of the Panhandle proper, competent authorities estimate that in 1943-44 three million ducks wintered on the large natural lakes including the Muleshoe National Wildlife Refuge and Blackwater Draw. As a whole, this area is a major wintering ground for mallards, pintails and lesser Canada geese. In 1942, the year of the big diving duck flight through the Plains, 1,200 canvasbacks and more than 2,000 American mergansers wintered at Buffalo Lake.

Southward migration scarcely ends before the northbound movement starts. As early as the middle of January some mallards are paired, and the first courtship flights of the pintails are in progress. Before the end of January, pintails arrive in numbers from farther south. Courting parties are now common, and some pintails are now paired. If the weather is mild, other species of ducks arrive early in February. By the middle of February, the pintail flight reaches its peak, and diving ducks begin to arrive. March is the month for most ducks to appear in force, courtship flights are commonplace until the middle of the month, but become less common as spring advances. A strong flight of ruddy ducks arrives late in March, but blue-winged and cinnamon teal are scarce until mid-April. After April, the resident population is composed of non-breeders and local nesters.

## SUMMARY

1. The High Plains region, and particularly the Texas Panhandle, deserves to rate among the foremost waterfowl areas in America during migration and throughout the winter.
2. Its attractiveness to waterfowl is due to its position astride the main arterial of the central flyway, its extensive system of lakes, including a potential area of a quarter million acres of playa lakes in widely-distributed units averaging 40 acres each, and its extensive feed fields.
3. The rainfall for the area usually is light and erratic. Consequently only a fraction of the lakes may contain water at one time. Crops frequently fail due to drouth, and the procurement of sufficient feed becomes a problem.
4. Despite these limitations, ducks are present in the Panhandle throughout the year and at least 7 species have been recorded nesting in the area. Fall, winter and spring waterfowl populations run into the millions.
5. Large concentrations of ducks consume many tons of feed per day. Natural vegetation usually furnishes little feed in the Panhandle. Grain sorghum crops provide the staple diet. Of 93 farmers

who replied to a questionnaire, more than half reported crop damage caused by waterfowl or cranes. Resentment runs high against waterfowl on that account.

6. Fowl cholera which is prevalent in parts of the Panhandle, is deadly to wild fowl as well as poultry. Farmers are instrumental in spreading the disease by carelessly disposing of diseased carcasses.

7. Duck hunting in the Panhandle is not well developed, and the kill is light, but goose hunting is fast becoming a very popular sport, and the 1945 kill was dangerously high.

8. The sex ratio of pintails was 3 drakes to 2 hens, but hunters killed 2 drakes to 3 hens, an undesirable condition. Baldpates had an age ratio of 11 juveniles to each adult; in two species of diving ducks it was 40:1 in favor of juveniles. Diving ducks evidently use the High Plains arterial extensively during wet years, but avoid it during dry years.

9. Seven per cent of 739 ducks banded were reported dead by the end of the second hunting season. The mortality rate in baldpates was highest, pintails next and mallards last. A rapid rate of turn-over was indicated by the records of ducks trapped more than once.

10. The southern Panhandle and adjacent counties compose a wintering area of considerable importance to mallards, pintails and lesser Canada geese. Estimates for the Muleshoe Refuge area have been as high as 3 million ducks; for Buffalo Lake and vicinity more than a half million. Goose numbers have exceeded 10,000.

11. Mallards began to pair by the middle of January, and pintails by the end of the month when northward migration already is under way.

(This study was made during off-duty hours while a member of the army, stationed at Amarillo, Texas.)

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# Opportunities for Post-War Employment in the Wildlife Field

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Biology is defined as the science of life, and a biologist as a student of biology, or in other words, a student of the science of life. These are broad terms that cover a large field from shrews to elephants, algae to redwoods and mites to cockroaches. In general, biology covers everything involved in the study of flora and fauna. In the wildlife field, however, we are inclined to think of a biologist as a student of wildlife, and wildlife we have narrowed to include only our wild fauna, separated from consideration of domestic species that man cultivates in husbandry. A biologist then, from our point of view, is one who has been specifically trained in wildlife work. From the standpoint of job classification, however, biologists are again narrowed down in their field to those dealing largely with birds, mammals, fishes, reptiles, and amphibians. Fishery biologists are known as aquatic biologists, and are purposely excluded from consideration in this discussion.

It is desirable to separate the usual job classifications that cover wildlife work, of which a biologist is only one. There have been several papers prepared in the past few years by educators[1] and administrators [2] [3] which attempt to give an appraisal of employment opportunities. I shall attempt to show what appears at this time to be the important positions suitable for personnel well trained in wildlife work. It will include not only biologists but veterinarians, bacteriologists, ornithologists, mammalogists, nutritionists, bio-chemists, botanists, pharmacologists, and others. This will be taken up in two parts: first, opportunities for employment directly in wildlife work with Federal, State, and private agencies; and second, employment of biologists in other related and unrelated fields, including forestry and agriculture.

## ANALYSIS OF THE WILDLIFE EMPLOYMENT FIELD

### Wildlife Research

Wildlife research is a growing specialized field in both Federal and State work, and some institutions—both public and private—employ research biologists. The advent of the Pittman-Robertson Act opened a vast field of state employment for biologists to study game and fur problems. It should be stressed that no longer can one be trained generally for wildlife research. We must have men who have taken advanced training in some specialized fields, for example, the problems of big-game, upland game, mammals, waterfowl, and fur resources. Just a knowledge of these species and their life histories and habits is not enough. It requires that the student be grounded in devising methods and techniques for the conduct of research, have a knowledge of ecological principles, and better yet, be acquainted with plant and animal associations in the region in which he hopes to be employed. The wildlife research field is broad, and without question, there will be employment opportunities for at least 100 to 200 biologists by July 1, 1946. The Fish and Wildlife Service, hopes, God and Congress willing, to have positions available for at least 40 new biologists in wildlife research. In addition to work on field problems, there is an opportunity for those trained in laboratory techniques embracing food habits, nutrition, diseases and parasites, physiology and anatomy, biochemistry, genetics, embryology, and related activities. In the minds of the administrators, laboratory work offers employment for the physically handicapped. The G. I. Bill of Rights, as you know, grants the veteran a generous period of education and training for both the physically fit and those handicapped. I recently witnessed a demonstration by two veterans who had both their hands severed in action. These men were able to operate laboratory equipment and machines dexterously, and it was almost beyond belief how efficiently they could perform their duties. We should remember, however, that the field of employment in wildlife research under State, Federal and institutional sponsorship is rather restricted. Educational institutions should keep this in mind in devising their educational program, as the bulk of employment in the future will be of an operational and administrative nature.

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[1] "Employment in the Wildlife Field," by Leonard Wing, Journal of Wildlife Management, Vol. 7, No. 3, pp. 261-270.

[2] E. Sidney Stephens, 1941, "The Role of Organized Groups in the Conservation Movement," 35th Conv. Int. Ass'n. Game, Fish, and Conservation Commissioners, pp. 21-28.

[3] "Colleges and Universities Offering Courses in Wildlife Management." 1938, Fish and Wildlife Service Leaflet 98.

## Wildlife Management Operations

It has not been long since Aldo Leopold brought to the attention of scientists throughout the Nation that there was a field in game management for specially trained personnel. Educational institutions of the country have turned out a creditable number of men qualified for jobs as biologists, game protectors, refuge managers, administrators, game and fur farm operators, and biologists trained for bird and mammal control work. Let us analyze for a moment some of the job opportunities in Federal and State work. As you perhaps are aware, the usual entrance grade for scientific work in the Federal Government is through the junior biologist P&S-1 series or as sub-professionals. In normal times these positions are established and filled by competitive Civil Service examinations. During the war, however, through the scarcity of personnel, War Service Appointments were authorized. It will not be long before Civil Service will return to competitive examinations and established registers for filling all positions. In the reconstruction period, when war agencies are being liquidated and employees of Federal organizations are returning to their former jobs, the opportunities for the employment of non-veterans will be very slight. It means only veterans and those who were dropped from other related Civil Service jobs will be obtaining immediate employment. Veterans who left Federal Services were placed on military furlough and are being given an opportunity to return to their former positions within six months and in some cases one year after their discharge.

The expansion for employment in the Fish and Wildlife Service will not come for some time, as V-J Day caught us unawares. The 1946 fiscal year is well underway on appropriations passed by Congress before June 30. Our appropriations were on a war-time basis and hence most of our peace-time activities were cut to a maintenance level. It will not be possible to recover fully the ground lost by the war until Congress restores these activities and provides for post-war projects. We do have one activity, however, which has taken on a considerable number of men and that is the river basin studies, under the adiminstration of Rudolph Dieffenbach. This work, in cooperation with the Bureau of Reclamation and Army Engineers, is for the purpose of conducting biological surveys on proposed water impoundment projects throughout the United States with the idea of including in the plans for such impoundments practical measures and considerations for the benefit of fish and wildlife.

As to employment by State game and conservation commissions, it looks promising for employing a large number of trained men on post-war projects. At the time Mr. Sidney Stephens made his survey, which was presented to a meeting of the International Association of Game and Fish Commissioners, in St. Louis in 1941, there were about 7,800 permanent fish and game employees engaged in State work. The tendency is to increase the annual pay scale of certain of the former underpaid positions, such as game wardens, game farm operators, and refuge personnel. This, in itself, is bound to attract a large number of men who are college trained. State game commissions have a large list of Federal Aid projects which will be administered by the State and should result in the employment of 500 or more new people.

## Wildlife Extension

Negotiations are underway to provide for a new cooperative agreement between the Fish and Wildlife Service and the Extension Service in the U. S. Department of Agriculture for wildlife extension work. As now planned, this will be established as a National program. Several States, of which Texas is one, have continued to foster a State wildlife extension program. The new plan will try to visualize the coordination of State extension programs and furnish from the National level sound technical assistance in the proper conduct of State and county wildlife projects. It should be apparent that the opportunities for employment will not be immediate for very many people, as it will take some time to get this work organized. In some States where county areas are large, without doubt county wildlife extension specialists will be employed. I visualize the day when there will be a good many of these employees attached to county extension offices. The programs would include not only extension in wildlife management but also fur farming, rabbit raising, farm fish pond development, rodent and predator control, and many activities that are a part of our agricultural picture. It will not be long before some form of wildlife extension will be organized with business, professional and industrial groups, which envisions consideration of wildlife recreational values.

### Wildlife Teaching

According to studies now being conducted by Dr. Gustav Swanson, in Charge of the Cooperative Unit Program, the number of schools offering specialized courses in training for wildlife management has not changed appreciably in the past 8 years. At our last count in 1937 there were about 36 colleges and universities offering such courses; among them were institutions in which the 10 cooperative wildlife units are located. It is apparent that if we are to have a recognized wildlife profession, certain standards will need to be prescribed in training opportunities. I believe this is opening up a special field for professors and instructors in colleges and universities—positions with more attractive salaries. There are between 30 and 40 now teaching wildlife conservation in schools offering a curriculum unheard of 10 years ago. There should be opportunities for training prospective conservation teachers in State teachers' colleges, who will in turn teach conservation courses in colleges and high schools.

### Private Institutions and Organizations

There are many organizations scattered throughout the country who are employing and will continue to employ more personnel trained in the wildlife field. Such organizations as the American Wildlife Institute, National Audubon Society, Izaak Walton League, The Wilderness Society, National Wildlife Federation, Campfire Club of America, National Pest Control Association, and as time goes on, others seem more inclined to employ administrative and operating personnel with a biological background. Then there are the hunting associations through the South, from Texas to Georgia, which have been pioneered by such biologists as Herbert L. Stoddard and E. V. Komarek. These men now own, manage wildlife areas, and are consultants for large estates. Landowners of large holdings will employ wildlife people on their farms to do their soil conservation work and provide better hunting and fishing. There seems to be a tendency for associations of wealthy landowners—particularly duck clubs—to be interested in hiring as their resident managers, men who are trained biologists. This would be a good field of employment, particularly for some of our returning veterans.

### FIELDS CLOSELY RELATED TO WILDLIFE MANAGEMENT

If you will stop to analyze the employment field, you will note that there are a larger number of related activities which offer employment of biologists or persons with dual training. By dual training, I mean majoring in one particular field and minoring in wildlife conservation. These fields are forestry; range management; branches of agriculture, such as soil conservation, animal husbandry, plant industry, entomology, agricultural economics; and believe it or not, home economics. There are also the fields of civil and hydraulic engineering, which I know you will agree should have some engineers with a biological background. We are in the midst of a big post-war National river basin development program, which contemplates not only flood control and navigation, but power, irrigation and drainage. The engineers are out to remake the face of America.

There is the field of public health, with a varied list of specialists, employed largely in the prevention and suppression of disease and parasites. While job titles do not give much of a clue, biology is a prerequisite for employment in this field, and persons who are familiar with rodent and insect control methods are in demand. This field offered many a military commission during the war. Public health will continue to need biologists, with new and powerful insecticides in use such as DDT and rodenticides as 1080.

Industry also opens up a big field for wildlife people who have some training in bio-chemistry, pharmacology, and fur dressing, dyeing, and manufacturing, which employs thousands of people. The fur auction houses are now beginning to employ some wildlife personnel. I believe I could go on indefinitely enumerating the opportunities for employment which are now showing up among industrial concerns. The field of transportation is another one. The war has given us tens of thousands of pilots, and it is obvious that more and more airplanes will be used in wildlife research and administration. I believe the pilot, trained in biology, will have little difficulty in obtaining employment within a few years, not only in this country but in foreign countries as well.

In the field of public relations, the opportunities have not been fully appreciated for the employment of men with a biologist's background. I look for the large daily papers of the Nation to employ an increasing number of wildlife editors and reporters. The daily press should protect itself from much of the trash (much of it not factual) that is being sent over the wires from various parts of the world. Many people believe eagles will pack off babies and lambs. How can the average sports writer, trained as a journalist, expect to know his natural history?

Then there is the field of radio, in which opportunities seem to be increasing for the employment of out-door editors and commentators. I know of one chain—and particularly one station—which is making an attractive offer for a technically trained wildlife biologist to direct their fish and game program. There are many organizations—both public and private—which employ editors to edit books, pamphlets, periodicals, and press releases on biological subjects.

With the advent of color in photography, a very profitable field is opening up for artists interested in the out-of-doors. I visualize that motion picture companies in Hollywood and elsewhere will employ wildlife technicians to lend better factual backgrounds to their productions. I think all of us remember films that must have cost hundreds of thousands of dollars to produce, which were full of glaring biological mistakes.

There is also a big field for feature photographers and lecturers. As you well know, there are many of them regularly booked up on winter circuits appearing under the auspices of the National Audubon Society, Academies of Science and educational institutions. One does not need to be a Cleveland Grant, Olin Pettingill, or Wesley Kubichek, to qualify.

And last, but perhaps not the least, opportunities exist in the legal profession with some wildlife training as a background. I believe if we had in all the States, men with some training, and especially in wildlife work, our conservation laws and regulations would be better prepared and understood.

Now that the war is over, I think that we shall see an era during which there will be a big upswing in interest, using our wildlife for sport and recreation. This means that we shall have greater numbers of hunters and fishermen in the fields and increased pressure on our game and fish populations. If we are to hold the ground we have gained since World War I and intelligently manage the resources, one need only to vision the great need for men—yes, and women too—with good biological training. The day of the barber shop biologist is about past. Politically speaking, our game administrators need no longer be picked from the public at large. Nor should the only qualification be that they love to hunt and fish, and are prominent members of local political groups.

We are entering a new period of consciousness in the need for conserving the Nation's resources, and to efficiently do the job it will require in the next 10 years several thousand trained and experienced persons. Here is an opportunity for educators, scientists and administrators to plan together. As has been noted, the number of positions available now and in the near future will be much less than the number of applicants. Competition will be unusually keen, and the well-trained biologist will have the advantage.

## Texas Game Wardens School

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In the present period of enlightened and planned wildlife conservation and management, the technology or know-how of the field has advanced beyond some of its related phases—law enforcement for example. Although the law enforcement branch of wildlife management is the oldest historically, in most states it has progressed far less rapidly of late years than others. Why is this so?

There are three main reasons that occur to me.

1. In our early attempts at law enforcement, we copied the code of the frontier from which we were not far removed in time. If a hunter or fisherman violated the game laws, the warden's duty was to catch him and get a conviction, a fine, or a jail sentence, or both. In some instances his success was judged by the number

of arrests and convictions to his credit and in some areas his livelihood and salary depended on the amount of fines paid into the coffers of the state. In short, the psychology under which law enforcement divisions were operated was "do nothing until the crime has been committed and then get your man." Perhaps this was the correct psychology for the past, but conditions have changed. Where aggressive programs of trying to prevent game law violations by public enlightenment have been in operation, results have been gratifying and have come nearer achieving public support and cooperation in enforcing game laws and carrying out sound wildlife conservation measures.

2. Wardens over most of the nation have been, and still are, notoriously underpaid. The public has lacked interest and has not demanded otherwise. Some of us in the past have been prone, in our lethargy, to be satisfied with poorly qualified game wardens, with almost anyone who was willing to accept the underpaid position. The candidate often was not questioned as to his knowledge of the wildlife that he was to protect, or the laws he was to enforce. It was hoped that he would somehow acquire that knowledge in the course of events. Our major requirements seem to have been: can he get the game violator; can he hold his own in a rough and tumble; and can he write his name?

In Texas we have had some game wardens of this calibre. In this connection I am reminded of a Texas warden who, not many years ago, arrested and had convicted and fined a "culprit" who allegedly had an illegal river otter pelt in his possession. Later examination of the confiscated pelt proved that no violation of the law had been committed—the pelt was that of a coati, a close relative of the raccoon, and not of a river otter. This situation would not have arisen had the warden been trained for his job. The old axiom that we seldom get more than we pay for still holds.

3. The warden force in many instances has been a political football, subject to the whims and fancies of powerful politicians who, themselves, in some known instances, have been game violators of the worst sort. The warden got his job because he was a friend of Senator So-and-So, or was the friend of a friend of the Senator. Political patronage has been responsible for the appointment of hundreds of inefficient and incompetent game wardens throughout the United States. They often not only did not know the fundamental aspects of their job, but they cared less, for were they not "protected" and immune from dismissal? Other reasons for lack of progress in law enforcement could be enumerated, but the three I have mentioned are clearly in the forefront.

Fortunately, here in Texas the Game, Fish and Oyster Commission has for several years recognized the shortcomings of the past and has slowly been advancing the status of the game warden force. It is looking forward to a time when the game warden will not only be a leader in the community but also the wildlife expert of the local hunters and fishermen, and a preventer of violations, as well as the law enforcement officer; to a time when he will truly represent the

Commission in all of its functions in his community and do the job well because he is paid a living wage, has the know-how, the aptitudes, and looks upon his work as a career. We have such game wardens in Texas at present, I am happy to report, but there are noe enough of them.

You may be wondering what the new concept of a game warden is and what his qualifications and duties are. I have attempted below to list a few of them.

### QUALIFICATIONS

1. He should have the ability to get along with people, to meet the public, to control his temper in delicate situations, and have courtesy and tact.

2. He should be able to sell himself and his program on individual and group contacts.

3. He should be industrious, honest, trustworthy, courageous, tolerant, possess a sense of humor, and exercise judgment.

### DUTIES

1. Know the game laws and the important wildlife of the state.

2. Prevent violation of game laws by carrying out a program in his district of public education and public relations, including talks to sportsmen's clubs, civic clubs, schools, working with boys groups, etc.

3. Apprehend game law violators, collect evidence, and present his case successfully in court.

4. Serve as the wildlife "technician" for the sportsmen and land operators in his community.

As a step in this dirction, the first Game Warden School in Texas associated with an institution of higher learning is to be placed in operation February 1, 1946, at the Agricultural and Mechanical College of Texas under the joint auspices of the Texas Game, Fish and Oyster Commission and the Department of Fish and Game at the College. By this move, Texas is placing herself in the forefront of the Nation along with Pennsylvania, which led the movement and has had a school in operation for several years. I have unofficial reports that Oklahoma also has similar plans under consideration.

As planned, the Texas school will operate for one semester of four months. The candidates will be selected by the Commission from applications filed with it. The course of study will include (1) wildlife conservation and management, (2) fish conservation and management, (3) natural history of the vertebrates, including fish, frogs, reptiles, birds and mammals, (4) game and fish laws and law enforcement, (5) public speaking, (6) public relations, and (7) report writing. Most of these courses will carry college credit that will count toward a college degree should individuals decide to further their education. This necessitates that candidates be high school graduates and meet college entrance requirements, or, in some instances, they may enter under College provisions as special students, in which case no college credits will be allowed.

Members of the staffs of the departments of English, Agricultural Education, and Fish and Game of the College, and a representative of the Commission will collaborate in the instructional phases of the program.

Enrollment in the first school will be limited to thirty. Those who satisfactorily complete the program of training will be placed on the eligible list from which vacancies in the Texas game warden force will be selected.

# CONSTITUTION
# Of The
# TEXAS ACADEMY OF SCIENCE

## Adopted November 8, 1945

### ARTICLE I — NAME

The name of this organization shall be "THE TEXAS ACADEMY OF SCIENCE."

### ARTICLE II — PURPOSE

The purpose of this Academy shall be to stimulate scientific research, to promote fraternal relationship among, and the general welfare of, those engaged in scientific work, especially in Texas; to diffuse among the citizens of the state a knowledge of the various departments of science; to investigate and report on any subject of science, or industry, when called upon by any department of the State government; and to publish reports of investigations and discussions conducted by Academy members.

### ARTICLE III — MEMBERSHIP

SECTION 1. *Classification:* The membership shall consist of regular members, life members, fellows, patrons, honorary life fellows, and honorary members.

a. *Regular Members.* Any person engaged in scientific work or in the promotion of science is eligible for membership. Such members may be elected at any regular meeting of the Academy upon the recommendation of two members in good standing and upon the payment of the annual dues. Regular members may be enrolled between annual meetings by the Executive Council subject to confirmation by the Academy at the next regular meeting.

b. *Life Members.* A regular member who contributes $50.00 in one sum to the funds of the Academy automatically becomes a life member and is exempt from further dues.

c. *Fellows.* A member of the Academy in good standing who is engaged in scientific research or in the administration of scientific work may, by the Executive Council, be nominated a fellow on the following conditions: (1) he must have held membership in the Academy at least one year prior to his election, (2) he must present to the Academy for permanent file a copy of a publication of merit of which he is the author, (3) he must receive a two-thirds majority of the votes cast by the members present at an annual meeting. Any fellow of the American Association for the Advancement of Science who is elected to membership in the Texas Academy of Science shall automatically become a fellow in the Academy.

d. *Patrons.* A person who shall contribute $500.00 in one sum to the funds of this Academy may be elected a patron. Election to "patron" shall carry with it the privileges of life membership and the exemption from dues.

e. *Honorary Life Fellows.* Any scientist resident in Texas who has rendered the Academy distinguished service of a scientific or administrative nature may be elected by the Executive Council an "Honorary Life Fellow." This honor shall entitle the recipient to all fellowship privileges and exemption from dues.

f. *Honorary Members.* Anyone who has rendered distinguished service to the Academy or to science may be elected an honorary member. This honor shall carry with it all the privileges of the Academy except those of voting and of holding office.

### ARTICLE IV — SECTIONS

SECTION 1. The Academy shall be divided into sections according to the major interest of its members.

SECTION 2. Members and fellows shall designate the section to which they belong.

### ARTICLE V — INTRA-ORGANIZATIONS

SECTION 1.a. *Regional Branches.* The Executive Council may establish regional branches on the petition of the majority of the members in good standing residing in the territory within which the branch is desired.

b. *Organization of Regional Branches.* Regional branches shall choose their own form of government and their own officers, provided their laws are in harmony with the Constitution and By-Laws of the Academy.

c. *Territorial Boundaries.* The territorial boundaries of each Regional Branch shall be subject to the approval of the Executive Council. The Regional Branches are declared duly established when the Executive Council has approved the petition for a Regional Branch.

### ARTICLE VI — JUNIOR ACADEMY

SECTION 1. *Junior Texas Academy of Science.* The Texas Academy of Science shall promote the organization and operation of science clubs in connection with accredited public and private schools of the State of Texas. These clubs when duly affiliated shall together constitute and be known as the Junior Texas Academy of Science.

### ARTICLE VII — COLLEGIATE DIVISION

SECTION 1. *Collegiate Division.* The Texas Academy of Science shall promote the organization and operation of science organizations in the colleges and universities of the State of Texas. These organizations when duly affiliated shall together constitute and be known as the Collegiate Division of the Texas Academy of Science.

### ARTICLE VIII — AFFILIATED ORGANIZATIONS

SECTION 1. Any scientific organization in Texas may become an affiliated organization of this Academy upon the approval of the Executive Council.

### ARTICLE IX — EXECUTIVES

SECTION 1. *Officers.* The officers of this Academy shall be a President, an Executive Vice-President, a Vice-President for each section, a Secretary-Treasurer, an Editor, a Representative to the American Association for the Advancement of Science, and three Directors. These officers shal perform the duties usually devolving upon such officers and as provided for in the By-Laws. Only fellows are eligible for election to these offices.

SECTION 2. *Election of Officers.* Method of Election of Officers and Members of the Board of Directors: Two months prior to the annual meeting the secretary shall mail to each member of the Academy in good standing a ballot compiled by the Elections Committee for the election of eligible members to fill all vacancies subject to election by the Academy members at large. This ballot shall carry two nominees for each office to appear alphabetically for each office except that in case the Executive Vice-President consents to accept nomination for the presidency his name shall be first in his group. The Elections Committee shall place no name on the ballot until the candidate's consent to serve, if elected, shall have been received in writing by the committee chairman and his standing shall have been vouched for by the Treasurer. Blank spaces shall be provided on the ballot for writing in of names other than those printed on the ballot.

Each member voting shall mark, sign and mail his ballot to the Secretary-Treasurer not later than three weeks prior to the annual meeting. The Secretary-Treasurer shall O.K. those envelopes received from members whose dues are paid for the current year and deliver them to the Elections Committee which shall count the ballots and announce the results of the election at the opening business session of the Academy. The officers thus elected shall assume their duties at the close of the final business session of the Academy.

SECTION 3. *Terms of Office.* All officers, with the exception of the Secretary-Treasurer, the Editor, the Representative to the AAAS and the three elected members of the Board of Directors, shall hold office for one year, or until their successors have been elected and are duly qualified. The Secretary-Treasurer and the Editor shall be elected on odd-numbered years for a period of two Academy years and the Representative to the AAAS shall be elected for two years on even-numbered years and shall hold office until his successor has been elected and is duly qualified.

SECTION 4. *Executive Council.* a. The Executive Council shall consist of the President, the Vice-Presidents, the Secretary-Treasurer, the Editor, the Representative to the AAAS, the Chairman of the Collegiate Committee, the Chairman of the Junior Academy Committee, the immediate Past President, and the Presidents of the Regional Branches. Four members of the Council shall constitute a quorum for the transaction of business provided that a sufficient notice is sent to all members of the Council in advance of the meeting. The designated representative of each affiliated society shall be an associate member with all privileges except that of voting.

b. *Duties of the Executive Council.* The duties of the Executive Council shall be those provided for in the By-Laws.

SECTION 5. *Board of Directors.* a. The Board of Directors shall consist of the President, the Executive Vice-President, the Secretary-Treasurer, the immediate Past President, and three members in good standing. The President, Secretary-Treasurer, and immediate Past President shall serve as ex-officio members. The other members shall be elected, one each year, to serve for a term of three years.

b. *Duties of the Board of Directors.* The Board of Directors shall
(1) have authority to represent and act for and on behalf of the Texas Academy of Science in all legal transactions.
(2) review all proposed amendments to the Constitution and shall submit a written report of its recommendations thereon.
(3) serve as the Court of Judgment on any question of the interpretation of the Constitution, or the constitutionality of any act committed by the Academy or its agents.
(4) shall pass on the budget prepared by the Secretary-Treasurer and authorize the disbursement of the current fund.
(5) invest the Permanent Funds of the Academy and shall make an annual report of the status of this Fund.
(6) make an annual report of its actions to the Academy and submit a copy of the minutes of each meeting for file with the Secretary-Treasurer of the Academy.
(7) shall appoint members to the Board of Development.

c. The new Board of Directors, at the close of each annual meeting, shall convene and organize at the call of the incoming President.

d. Four members of the Board shall constitute a quorum. The Chairman shall have full voting privileges irrespective of the division of the Board.

## ARTICLE X — COMMITTEES

SECTION 1. a. *Standing Committees.* The standing committees shall be as follows: (1) Program, (2) Publications, (3) Elections, (4) Affiliations, (5) Junior Academy, (6) Library, (7) Membership, (8) Research Grants, (9) Collegiate Division, (10) Necrology.

b. The President shall be authorized to appoint, subject to the confirmation of the Executive Council, all members of the standing committees, except those otherwise provided for.

SECTION 2. *Special committees.* The President shall be authorized to appoint such special committees as the welfare of the Academy may require.

SECTION 3. a. There shall be a Board of Development, the duty of which shall be to devise and put into effect ways and means for establishing and maintaining a sound financial position for the Texas Academy of Science.

b. The number of members, the terms of office, and the manner of selection shall be determined by the Board of Directors.

## ARTICLE XI — AMENDMENTS

SECTION 1. *Amendments.* This Constitution may be amended at the final business session of any annual meeting of the Academy by a three-fourths majority of the attending members of at least one year's standing; provided, that the proposed amendment is accompanied by a written opinion (either for or against) of the Board of Directors, and provided further that the proposed amendment be read to the membership at least one day previous to balloting.

## BY-LAWS OF THE ACADEMY

### ARTICLE I — DUTIES OF OFFICERS

SECTION 1. The President, in addition to being the chief executive officer of the Academy, shall serve as chairman of the Executive Council. He shall convene the incoming Board of Directors at the close of each annual meeting and shall serve as a member thereof. He shall fill all vacancies in elective positions subject to the approval of the Executive Council. He shall be an ex-officio member of all committees.

SECTION 2. The Executive Vice-President shall serve as vice-chairman of the Executive Council. He shall serve as general chairman of the Program Committee. He shall perform such other duties as the President and Executive Council may designate. In case of the death or resignation of the President he shall succeed to that office.

SECTION 3. The sectional Vice-Presidents shall serve as program chairmen of their respective sections and as members of the Executive Council.

SECTION 4. The Secretary-Treasurer shall, in addition to the usual duties of that office, serve as ex-officio secretary of the Executive Council and of the Board of Directors. He shall serve as Recording Secretary at all meetings, shall issue certificates of membership, and shall issue charters to chapters of the Junior Academy.

He shall be the custodian of all funds of the Academy. He shall have his accounts audited by a Certified Public Accountant and shall present the audited report to the Academy as directed by the Board of the Academy. He shall prepare a budget of estimated income and expenditures, and shall present the same to the Board of Directors for approval within thirty days after the last annual meeting of the Academy. He shall disburse the Current Funds and shall invest the Permanent Fund on order of the Board of Directors. He shall keep an up-to-date roster of paid-up members.

SECTION 5. The Editor shall serve as chairman of the Publications Committee and shall have charge of the editing and publishing of all Transactions and Proceedings of the Academy and of all other publications not otherwise provided for.

SECTION 6. The Representative to the Council of the AAAS shall represent and promote the Academy's interests in that organization.

### ARTICLE II — DUTIES OF EXECUTIVE COUNCIL

SECTION 1. The duties of the Executive Council shall be as follows:

(1) Nominate regular members to the rank of fellows.
(2) Elect Honorary Life Fellows.
(3) Create new sections of the Academy or re-divide the present ones when the best interest of the Academy warrants such action.

(4) Pass on the applications for the organization of Regional Branches and determine the geographic boundaries of such Branches.
(5) Pass on the applications of Affiliated Organizations.
(6) Authorize the colection of registration fees in connection with annual meetings.
(7) Approve appointments to vacancies that may arise between annual meetings, unless otherwise provided for.
(8) Determine the time and place of annual meetings.
(9) Approve time and place of Branch meetings.
(10) Authorize special meetings of the Academy.
(11) Confirm standing committee members nominated by the President.
(12) Elect the members to the Junior Texas Academy of Science Committee, one each year.
(13) Elect the members to the Collegiate Division Committee.
(14) Review and approve requirements for membership to the Junior Academy and grant charters to chapters.
(15) Transact such other business as may arise which has not been provided for, except matters dealing with the financial affairs of the Academy.

## ARTICLE III — FINANCES

SECTION 1. *Funds.* The funds of the Academy shall be divided into (a) Permanent Fund and (b) Current Funds. The Permanent Fund shall consist of all moneys paid by Patrons and Life Members upon election and all gifts and legacies. All gifts and legacies together with interest thereon shall be used only for the purposes specified by the donors. The Current Funds shall be made up of all other income including interest from the Permanent Fund unless otherwise provided for.

SECTION 2. *Dues.* The annual dues for regular members shall be $2.00, except that the dues for students in college shall be $1.00.

SECTION 3. Members whose annual dues are in arrears more than one year shall be dropped automatically, after due notice, and may be reinstated only by a majority vote of the Executive Council. Publications shall be sent only to paid-up members. Members in the Armed Forces shall be regarded in good standing without payment of dues until six months after discharge from the service.

SECTION 4. Members of the Junior Texas Academy of Science shall pay dues in accordance with the provisions of the Junior Texas Academy Committee. After graduation from high school such members automatically become active members in the Academy without the payment of any dues for the remainder of the academic year during which graduation occurs.

## ARTICLE IV — SECTIONS

SECTION 1. The present division into sections shall be:

*Sec.* I. Astronomy, Chemistry, Engineering, Mathematics, Physics.

*Sec.* II. Agriculture, Botanical Sciences, Medical Sciences, Zoological Sciences.

*Sec.* III. Anthropology, Education, Historical and Philological Sciences, Psychology, Social and Economic Sciences.

*Sec.* IV. Geography and Geological Sciences.

*Sec.* V. Conservation.

SECTION 2. The Executive Council shall be authorized to make additions to, or re-divisions of, the sections when the need arises. Permanent changes in sections shall be made only by amendment to the By-Laws.

### ARTICLE V — MEETINGS

SECTION 1. Meetings of the Academy shall be of two classes: (a) regular meetings and (b) special meetings. Regular meetings shall be of two types: (1) Annual meetings and (2) Branch meetings.

SECTION 2. The time and place of annual meetings shall be determined by the Executive Council within ninety days after the preceding annual meeting.

### ARTICLE VI — THE JUNIOR TEXAS ACADEMY OF SCIENCE

SECTION 1. *Aim.* The Texas Academy of Science shall promote local science organizations in the accredited public and private schools of the State of Texas. When duly chartered by The Texas Academy of Science, these organizations shall constitute the Junior Texas Academy of Science.

SECTION 2. The Junior Texas Academy of Science shall be under the direction of the Junior Texas Academy Committee. This committee shall consist of seven members to be elected annually by the Executive Council of the Academy. This committee shall (a) appoint for each organized region a Regional Director of the Junior Academy activities and (b) formulate the requirements for membership in the Junior Academy subject to the approval of the Executive Council and (c) grant charters to Junior Academy chapters subject to review by the Executive Council.

SECTION 3. Any local science organization which meets the requirements shall upon the recommendation of the committee in charge receive from the Secretary-Treasurer of the Academy a charter of membership in the Junior Texas Academy of Science. The charter shall be valid as long as the chapter meets the requirements.

SECTION 4. The officers of the Junior Texas Academy of Science shall be for each organized region: A Regional President, Regional Vice-President, and Regional Secretary-Treasurer. These officers shall be elected for one year at the regional meeting which shall be held in conjunction with the regional meetings of the Texas Academy of Science. The officers, together with the Regional Director, shall constitute the regional executive council of the Junior Texas Academy of Science.

SECTION 5. The Junior Academy Committee and the Junior Regional Executive Council shall formulate and agree upon a program of work and present a proposed budget which shall be included in the budget presented to the Board of Directors by the Secretary-Treasurer.

SECTION 6. A report shall be made by the Junior Academy Committee at each annual meeting of the Academy on the progress and status of the work of the Junior Texas Academy of Science.

### ARTICLE VII — THE COLLEGIATE TEXAS ACADEMY OF SCIENCE

SECTION 1. The Collegiate Texas Academy of Science shall be under the direction of the Collegiate Academy Committee. This committee shall consist of four members, namely, the Councilor elected by the state organization of the Collegiate Academy and three members of the Academy elected by the Executive Council, one to be elected each year and to serve for a period of three years.

SECTION 2. This committee shall be charged with the duty of supervising and promoting the work of the Collegiate Academy and shall make a report at each annual meeting of the Academy on the progress and status of the Collegiate Academy of Science.

SECTION 3. The Councilor shall be an ex-officio member of the Executive Council of the Academy.

### ARTICLE VIII — PROCEDURE AT ANNUAL MEETINGS

SECTION 1. The order of procedure at Annual Meetings shall be as follows:

(1) Opening business sesion
(2) Program sessions
(3) Final business session

SECTION 2. The order of procedure shall be based on Robert's Rules of Order unless otherwise decided by a majority of the members present and voting.

### ARTICLE IX — QUORUM

SECTION 1. The members in good standing, present at any business session or any annual meeting, shall constitute a quorum for the transaction of business.

### ARTICLE X — AMENDMENT

SECTION 1. These By-Laws may be amended by a majority vote of those present at the final business session of the annual meeting, provided the proposed amendment has been presented, read, and laid on the table at a previous business session.

# MEMBERSHIP OF THE TEXAS ACADEMY OF SCIENCE

August 24, 1946

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This list is compiled from the records in the Secretary's and Treasurer's offices from several different sources and much correspondence. Doubtless, there are many errors, omissions and changes of addresses not yet recorded.

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# Proceedings and Transactions
# of
# The Texas Academy of Science
# 1946

VOLUME XXX

SMITHSONIAN INSTITUTION
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Houston, Texas
Published by the Academy
1948

# Proceedings and Transactions

of

# THE TEXAS ACADEMY OF SCIENCE

1946

VOLUME XXX

Houston, Texas
Published by the Academy
1948

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# FOREWORD

The Academy is entering into its second half century. The semicentennial program containing some ninety contributions from the senior academy and twenty-seven more from the collegiate and junior academies indicates the degree of growth and maturity. This year the Academy is planning the consummation of an idea which has been in the mind of its older members for many years. It will establish a central headquarters for its far flung offices and activities. It will centralize the work of secretary and treasurer as well as editor in one person. The library will be merged with the University library and student privileges will be granted to Academy members. The Academy will assume a more important part in the life of the State of Texas by setting up a Council on Conservation covering all the important fields of study. It is our hope to greatly expand the Collegiate and Junior Academies and to improve the standards of their activity. In planning our own general programs and the publication of papers we must also raise the standard of performance.

In the initiation of the plans for an expanded Academy we pay homage to the enthusiasm of Dr. Fred Plummer our immediate past president who had vigorously gone out after new members and who had plans for increasing the publications of the Academy.

The papers and abstracts published in this volume represent the unedited opinions of the authors and not the official voice of the Academy.

Texas Academy of Science
John G. Sinclair
President

Sept. 1947

JUL 25 1949

# THE PREPARATION OF MANUSCRIPTS

The proceedings and Transactions are published in English. The editor reserves the right to reject manuscripts or to resubmit them for condensation. Minor changes in spelling, punctuation, etc. may be made without consultation. All manuscript must be submitted typewritten on white paper, double spaced with wide margins. All references are placed at the end of the article and are referred to by number consecutively. Give the author's name, title, journal, page, date of publication.

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Underscore words to be **italicized.** Omit reference to transient events or names that would mean nothing in a few years. Write impersonally if possible. Manuscript will not be returned. Reprints will be printed at cost.

Editor

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# PROCEEDINGS

## PROCEEDINGS OF THE TEXAS ACADEMY OF SCIENCE 1946.

There were no regional meetings held during 1946. The meetings of Boards and Committees are covered in their reports. The General meeting was held in Dallas in the Hotel Adolphus, December 12-13-14. Registration occurred on Thursday afternoon and Friday morning. The business sessions were held Thursday at 5 P.M. and Saturday morning at 8 A.M. Many of the officers and committees failed to report. The list of officers was announced at the last business session and committees were not appointed for some time thereafter but the official list as approved by the Executive Council is placed here. The following officers served to carry out the semicentennial program:

President F. B. Plummer. Dr. Plummer was out of the country and Executive Vice-President S. W. Warner resigned. This threw the burden of organization on Dr. W. T. Chambers.

Vice-Presidents of the sections and chairmen of the programs:

| | |
|---|---|
| Section I. | W. T. Gooch |
| Section II . | G. E. Potter |
| Section III. | O. R. Neilsen |
| Section IV. | Paul Weaver |
| Section V. | V. H. Schoffelmayer |

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Cornelia Smith

Chairman of the Collegiate session

Fred Barkley

Chairman of the Junior Academy session

Miss Grete Oppe

Local Committee on arrangements

E. P. Cheatum, Frank McDonald, Ogden Baine, Joe P. Harris, Jr., Mayne Longnecker, Walter Watson, C. A. Nichols, C. Albritton, Arthur Grollman, Landon H. Baker.

Report of the nominations and elections committee.

In accordance with Article IX of the Constitution the election of officers was conducted through the mail. The tabulated results were presented and resulted in the following selections:

For President. John G. Sinclair, U. of T. Med. School. Elected
W. T. Chambers, SAFSTC, Nacogdoches.

For Executive Vice-president
Paul Weaver, Gulf Oil Corp., Houston. Elected
G. E. Potter, Texas A. and M. College Station.

Vice-President Section I.
E. J. Prouse, U. of Texas, Austin. Elected
A. A. Jakkula, Texas A. and M. College Station

Vice-President Section II
A. A. Studhalter, Texas Tech., Lubbock. Elected
B. B. Harris, NTSTC, Denton.

Vice-President Section III
L. S. Paine, Texas A. and M. College Station. Elected
G. Worley, State Dept. of Education.

Vice-President Section IV
H. H. Power, U. of T., Austin. Elected
F. H. Dotterweich, Texas A. and I., Kingsville.

Vice-President Section V
J. L. Baughman, Game, Fish and Oyster Commission, Rockport. Elected
C. W. Pomerat, Med. School, U. of T., Galveston.

Secretary-Treasurer
Gladys Baird, SHTSC Huntsville. Elected
J. K. G. Silvey. NTSTC, Denton

Representative to the AAAS
C. D. Leake, Med. School, U. of T. Elected

Tabulation made by
E. P. Cheatum
W. R. Woolrich

Election committee
W. P. Taylor, Chairman
W. R. Woolrich
T. S. Painter
E. P. Cheatum
J. C. Godbey

Elections were announced at the second business session.

## OFFICERS, BOARDS AND COMMITTEES FOR 1947.

### OFFICERS

**President,** John G. Sinclair, Department of Anatomy, Medical Branch, University of Texas, Galveston.

**Executive Vice President,** Paul Weaver, Gulf Oil and Refining Corporation, Houston.

**Vice President, Section I,** E. J. Prouse, Department of Mathematics, University of Texas, Austin.

**Vice President, Section II,** R. A. Studhalter, Texas Technological College, Lubbock, Texas.

**Vice President, Section III,** L. S. Paine, A. and M. College, College Station, Texas.

**Vice President, Section IV,** H. H. Powers, University of Texas, Austin, Texas.

**Vice President, Section V,** J. L. Baughman, Game, Fish and Oyster Commission, Rockport, Texas.

**Secretary-Treasurer,** Gladys Baird, Sam Houston State Teacher's College, Huntsville, Texas.

**Editors,** M. M. Slotnick and L. W. Blau, Humble Oil Company, J. G. Sinclair, Galveston.

**Representative to the AAS.** C. D. Leake, Medical Branch, University of Texas, Galveston.

**Chairman, Collegiate Academy,** Fred Barkeley, University of Texas, Austin, Texas.

**Chairman, Junior Academy,** Miss Grete Oppe, Ball High School, Galveston.

### BOARD OF DIRECTORS (quorum 4)

President, J. G. Sinclair; past president, Fred Plummer (died Feb. 17, 1947), secr. treas., Gladys Baird; elected members: J. C. Godbey, 1947; W. R. Woolrich, 1948; E. P. Cheatham, 1949. W. P. Taylor appointed to fill out the term of Dr. Fred Plummer.

### EXECUTIVE COUNCIL (quorum 4)

Composed of the complete list of officers plus the immediate past president.

### BOARD OF DEVELOPMENT

**Chairman,** W. R. Woolrich, College of Engineering, University of Texas, Austin.

**Member.** Beauford Jester, Governor of Texas, Austin.

**Member.** L. W. Blau, Humble Oil Company, Houston.

**Member.** E. D. DeGolyer, Consulting Geologist, Dallas.

**Member.** O. S. Petty, Petty Geophysical Corporation, San Antonio.

**Member.** J. G. Sinclair, **ex officio.**

## COMMITTEES

**Membership:** Chairman, Paul Weaver; Don O. Baird; Claude Albritton; Gayle Scott; J. A. Place; Cornelia Smith; F. A. Barkeley; George Potter; O. A. Ullrich; W. T. Chambers; Amy LeVesconte; Sister Joseph Marie Armer; Dabney E. Petty; John Kelly; W. O. Milligan.

**Research Grants:** Chairman, Harold Vance; Gayle Scott, H. H. Power.

**Fellows and Honors:** Paul Witt, chairman; S. W. Bilsing, C. Smith.

**Affiliations:** Ide Trotter, chairman; W. T. Chambers.

**Publicity:** V. H. Schoffelmayer, chairman; A. G. Adair, E. Quillen.

**Necrology and History**: O. A. Ullrich, chairman; F. B. Isley.

**Publications:** M. M. Slotnick, editor pro tem for 1946-47; W. A. Price, chairman of the Handbook; C. R. Granberry, editor of 1945 Transactions; L. W. Blau, Otto Neillson, J. G. Sinclair.

**Auditing:** O. S. Petty.

**Regional Meetings**: Otto Watts, Western region; Velma Wilson and John Kelly, Southwestern region; S. A. Warner and Wayne Longnecker, Eastern region.

**Nominations and Elections:** W. R. Woolrich, chairman; W. P. Taylor; Don O. Baird; E. P. Cheatham; J. C. Godbey.

**Library:** W. S. Bilsing and George Potter.

**Collegiate Academy:** Fred Barkeley, counsellor; Amy LeVesconte, president; Otto Watts, editor of Tasca; Sister Joseph Marie Armer; Don O. Baird; C. Doak.

**Junior Academy:** Grete Oppe, counsellor; Addison Lee; M. Floyd; Edna Miner; Velma Wilson; Wayne Taylor.

**Local Committee:** Howard Degler, chairman; Paul Boner; H. R. Henze; C. M. Cleveland; C. Colvert; Fred Barkeley; B. C. Tharp.

**Council on Conservation:** John G. Sinclair, acting president; Human health, C. D. Leake; Human genetics, C. P. Oliver; Human economics, L. S. Paine; Water conservation, Paul Weaver. Others are to be appointed covering soil conservation for forest and range, for agriculture, minerals, oil and gas, marine resources, wild life, refuges and state parks, archeological and paleontological sites.

Report of the President **Pro tem.**

This is a meeting at which the officers of our organization report back to the members on their stewardship for the year. The first officer to report is the President, Professor F. B. Plummer. Professor Plummer has been unable to return from Brazil where he undertook some field work that will go far toward founding geological science in a vast and almost unknown region. Hence I shall remark upon his work as president of the Academy.

Dr. Plummer laid plans for this great semi-centennial meeting, in which we have been privileged to participate, some months ago. Meetings of appropriate officials were held and the broad outlines of the convention were mapped. It was determined that the convention should celebrate a half century of growth of science in Texas by featuring a symposium on the scientific achievements in this state during that period. The main speakers were suggested and it was planned to secure a scientist of national reputation to serve as a speaker at a banquet.

When Professor Wagner resigned as Executive Vice-President Dr. Plummer telephoned from a meeting of the Council, in Austin, asking me to undertake the responsibility of the office. I agreed to do so.

During July Dr. Plummer sent letters to me and to each of the Section Vice-Presidents urging us to get started in developing good programs for the December meeting. He also wrote each one telling them of his Brazilian trip and asking us to carry on until his return.

Wm. T. Chambers

The report was accepted for filing.

Report to the Secretary. November 7, 1945 to December 13, 1946.

During the past year the Academy held its regular meeting at Baylor University, Waco, November 8, 9 and 10. Section I, physical sciences had four papers. Section II, biological sciences had twenty-six. Section III, social sciences had five. Section IV, geography and geology had seven. Section V, conservation had eleven. In addition a symposium on the "Treatment of the Mentally Ill in Texas" was conducted. The Wildlife Society of Region 5 read eleven papers.

President Plummer launched an intensive membership drive early in the year; this was implemented by the secretary's sending out fourteen hundred announcements of the Dallas meeting for December 1946. The net result was 368 new regular members and 64 collegiates. Only 234 old members have paid their 1946 dues. Total membership is 1014 regular members and 242 collegiates. The secretary mailed out 432 certificates of membership. Ballots were sent to all members not more than one year in arrears with their dues.

Two weeks prior to the Dallas meeting each officer was reminded by letter to have his report in written form to present at the business session.

Cornelia M. Smith, Secretary.

The report was accepted for filing.

Report of the Treasurer Dec. 11, 1946

| | | | |
|---|---|---|---|
| Receipts. | | | |
| Cash balance as of audit Nov. 3, 1945 | | $2068.98 | |
| Receipts Nov. 3, Dec. 10, 1945 | | 2046.19 | |
| Total of money transferred to Garland Adair by Leo T. Murray Dec. 10, 1945 | | 4115.17 | |
| Receipts Dec. 10, 1945—Dec. 10, 1946 | | 1741.00 | |
| Total cash received | | $5856.17 | 5856.17 |
| Disbursements | | | |
| President's office | | $ 210.66 | |
| Secretary's office | | 109.10 | |
| Treasurer's office | | 111.10 | |
| Junior Academy (paid in one check) | | 79.00 | |
| Collegiate Division | | 167.68 | |
| Publishing and printing | | | |
| Gulf Publishing Company | $1659.37 | | |
| Firm Foundation | 48.27 | | |
| Firm Foundation | 21.40 | 1729.04 | |
| General Expenses: | | | |
| Bond for treasurer | $ 12.50 | | |
| Telegraph and telephone | 9.00 | 21.50 | |
| Total disbursement | | | $2428.08 |
| Balance available | | | $3428.09 |

| | |
|---|---|
| Location of Academy funds. | |
| American National Bank of Austin. Savings 1% | $1000.00 |
| Citizens State Bank of Austin. Savings 2% | 1723.00 |
| Citizens State Bank of Austin. Checking | 699.01 |
| Cash in banks | $3422.01 |
| Checks returned but resubmitted | 6.08 |
| Total possible available money | $3428.09 |

| | |
|---|---|
| Culyer Memorial Fund for publication of a brochure written by Robert Culyer. This separate account in Austin State Bank | $ 160.00 |
| Pledges of $5.00 cash each | 500.00 |
| | 660.00 |

| | | |
|---|---|---|
| Permanent Endowment Fund. | | |
| United States bonds: | | |
| Two $100 series C. purchased Jan. 1938 at $75.00 each. No current interest. Present redemption value $90.00 each | 180.00 | |
| Two $100 series G. purchased Aug. 1943 at $100 each. Interest 2½% semi-annual. Present value $96.20 each | 192.40 | 372.40 |
| Share account in First Federal Savings and Loan Association, San Antonio | 59.46 | |
| Total permanent endowment | | $ 431.86 |

All disbursements are within the budget approved by O. S. Petty.

A. Garland Adair

The report was accepted subject to audit not yet completed. Mr. O. S. Petty stated that he would accept the responsibility.

Report of the editor and chairman of the publication committee.

I am taking this means of reporting through you (Dr. Plummer) to the Texas Academy of Science concerning my activities as Editor and Chairman of the Publications Committee for the year 1946.

The Proceedings and Transactions, which will be available shortly, were delayed this year for two reasons. First, it was extremely difficult to obtain many of the authors copies of papers presented at the last meeting. After several major efforts, we were able to secure what I believe to be an unusually high percentage of papers, or abstracts, presented, but the last ones came in only a few weeks ago. Second, it was extremely difficult to find a printer who would agree to undertake the printing of the Proceedings and Transactions. This difficulty arose primarily because of the paper shortage. We were fortunate, I believe, to have Von Boeckman-Jones Company of Austin to do the printing. Every effort is being made to have this work completed at the earliest possible moment.

I am informed by the Treasurer, Mr. A. Garland Adair, that sufficient private subscriptions have been received to assure the printing of the Robert H. Culyer Memorial which was authorized at the Waco meeting. The copy for this material is in the hands of a special committee, and will be available for printing within a short time.

Respectfully submitted
C. R. Granberry

The report was accepted for filing.

As a result of the failure of the vice-presidents to report with the exception of George Potter for Section II and the resulting difficulty in assembling papers and abstracts Dean Ullrich moved that "a deadline date for papers for publication be set as the day of the date of the annual convention; and that it be the sense of the Academy that the Proceedings and Transactions be published as soon as possible after the convention date." The motion was seconded and carried.

Report on Societies Affiliated with the Academy

Central Texas Section, American Chemical Society
Dallas Astronomical Society
Dallas Nature Study Club
Dallas Ornithological Club
El Paso Archeological Society
Houston Museum and Scientific Society
North Texas Biological Society
San Antonio Science Club
Southwest Section, Society of Exper. Biol. and Medicine
Texas Archeological and Paleontological Society
Texas Association of Science Teachers
Texas Entomological Society
Texas Society of Pathologists
Texas Folk-Lore Society
Texas Nature Federation
University Science Club
The Texas Society of College Teachers of Education
West Texas Historical and Scientific Society

Report of the committee on Fellows and Honors:

We herewith submit a list of names for Fellowship in the Texas Academy of Science. In submitting this list we believe that we have recommended eligible and active members. Because of our need for recognizing all eligible members, our desire to overcome any laxity in this respect in the past, and our desire to make the list of Fellows commensurate with the growth of our Academy and our needs for material eligible for executive positions we have made extra effort to make the list as inclusive as possible. We admit the probability of omissions and of duplications.

1. On the basis of service to the Academy and nomination on important committees or executive offices in the Academy:

W. T. Chambers—SFTSTC, Nacogdoches, Texas
J. G. Sinclair—University of Texas, Medical Branch, Galveston

A. A. Jakkula—Texas A. and M. College, College Station
E. J. Prouse—University of Texas, Austin
B. B. Harris—NTSTC, Denton
L. S. Paine—A. and M. College, College Station
Gordon Worley—State Department of Education, Austin
F. H. Dotterweich—Texas A. and I., Kingsville
H. H. Power—University of Texas, Austin
J. L. Baughman—Texas Game and Oyster Commission, Rockport
C. W. Pomerat—University of Texas, Medical Branch, Galveston
C. D. Leake—University of Texas Medical Branch, Galveston

2. On the basis of being fellows in the AAAS:

Raymond F. Blount—University of Texas, Medical Branch, Galveston
C. P. Boner—Def. Research Lab. U. of T., Austin
M. G. Cheney—Coleman, Texas
A. A. Dunlap—A. and M. College, College Station
Edwin J. Forscue—S. M. University, Dallas
T. M. Hammond—Schreiner Institute, Kerrville
Carl L. Hubbs—Scripps Institute of Oceanography, La Jolla
Eugene Porter—University of Texas Medical Branch, Galveston
F. T. Rogers, Jr.—U. S. Naval Ord. Plant, Indianapolis, Ind.
Mary Elmore Sauer—University of Texas Medical Branch, Galveston
Ide P. Trotter—Extension Service, A. and M. College Station
Roger J. Williams—University of Texas, Austin

3. On the basis of published papers submitted:

A. Garland Adair—Texas Memorial Museum, Austin
T. R. Clark, Jr.—Abilene Christian College, Abilene
Roy L. Donahue—A. and M. College, College Station
Floyd W. Dunn—Abilene Christian College, Abilene
Joel W. Hedgpeth—Institute of Marine Science, Port Aransas
Sarah E. Jones—629 E. College St., Denton
Marcus E. Mullings—Abilene Christian College, Abilene
Coleman Newman—Box 133, Silsbee
Marguerite Rogers—Naval Ord. Lab., Indianapolis, Ind.
R. G. Upton—SFASTC, Nacogdoches
B. H. Warnock—Box 1532, Univ. St., Austin
Lewis Waters—3802 Maple Ave., Dallas

4. On the basis of titles of papers submitted or offer to submit materials for examination.
Roy H. Adams—SFASTC, Nacogdoches
Russel C. Artist—Westminster College, Salt Lake City, Utah
Fred A. Barkley—University of Texas, Austin
Horace R. Blank—Southwestern University, Georgetown
Edward R. Bogusch—629 W. Nettle St., Kingsville
Lucile Capt—Baylor Station, Belton
J. DeWitt Davis—Texas A. and I., Kingsville
W. B. Davis—Texas A. and M., College Station
Everette L. DeGolyer—1000 Continental Building, Dallas
E. J. Dysterhuis—4024 Wayside Ave., Fort Worth
George L. Edwards—Box 93, Brownsville
C. T. Eskew—Hardin College, Wichita Falls
James A. Gray—Texas A. and M. College Station
H. E. Hampton—Texas A. and M. College Station
J. V. Irons—Texas State Health Department, Austin
P. E. Jackson—Box 64, Silsbee
A. L. Kerbow—3220 Rice Boulevard, Houston
Jule K. Lamar—University of Texas, Medical Branch, Galveston
E. K. Leonardon—Schlumberger Well Corporation, Houston

Helen A. Ludeman—Box 2475, TSCW, Denton
S. A. Lynch—A. and M. College Station
Elizabeth J. Moore—Box 1683, University Station, Austin
Joseph Morgan—Texas Christian College, Fort Worth
Kelso B. Morris—Howard University, Washington
A. W. Mount—4326 Birchman St., Fort Worth
J. B. McBryde—615 W. Sycamore, Denton
John O. Nigra—74 Merlon Ave., Pasadena, California
L. S. Paine—A. and M. College Station
Wilber F. Pate—Diboll, Texas
John F. Pilcher—320 Med. Prof. Bldg., Corpus Christi
Edgar J. Poth—Med. Branch, University of Texas, Galveston
Homer E. Prince—Medical Arts Building, Houston
Cyrus N. Ray—Abilene, Texas
Edward Rischar—Cameron, Texas
O. E. Sanden—Science Service Inc., Winona Lake, Ind.
G. W. Schlesselman—A. and M. College Station
A. R. Schrank—University of Texas, Austin
Lloyd L. Shinners—S.M.U., Dallas
R. W. Strandmann—Medical Branch, University of Texas, Galveston
William E. Street—A. and M. College Station
Charles H. Taft—Medical Branch, University of Texas, Galveston
I .T. Taylor—Edna, Texas
Robert A. Vines—Box 2075, Houston
John H. Wilson—2210 Fort Worth National Bank Bldg., Fort Worth
Paul Ewing—Medical Branch, University of Texas, Galveston

5. On the basis of appearance on the Academy programs.

Sister M. Bernice—Our Lady of the Lake College, San Antonio
James L. Carrico—1922 W. Chestnut, Denton
J. Hollie Cross—Texas Tech. College, Lubbock
Gordon R. Harwell—5610 Clinton Drive, Houston
Jack M. McKay—909 Market St., Galveston
Marjorie Harsbarger—S. W. Med. Foundation, Dallas
B. E. Schultze—2919 Dempsey St., Corpus Christi
O. G. Speer—6342 Buffalo Speedway, Houston

6. On the basis of papers published or presented or on known qualifications accepted by the committee on fellowships.

H. T. Ettlinger—University of Texas, Austin
C. B. Godbey—A. and M. College, College Station
C. R. Granberry—University of Texas, Austin
Addison Lee—1703 W. 44th St., Austin
T. S. Painter—University of Texas, Austin
Glen S. Rabideau—University of Texas, Austin
G. R. Tatum—8621 Georgia Ave., Silver Springs, Md.
Walter P. Webb—University of Texas, Austin
Gordon Worley, Sr.—University of Texas, Austin

7. On the basis of name misspelled last year.

Robert P. Wagner—Mispelled Waggoner

8. Honorary Life Fellow—G. S. Fraps

Paul Witt, Chairman
Cornelia Smith

The list was unanimously approved. Upon motion of J. G. Sinclair it was agreed that the Committee should insert such names as it found were eligible at this time and inadvertently omitted.

Report of the Collegiate Committee of the Academy.

This year under the sponsorship of Dr. Fred Barkley, the Collegiate Academy has been especially active and successful. There has been a considerable increase in members, the attendance at the annual meeting has increased, and a larger proportion are paying full membership dues. Three new schools have received charters:

Science Club of Rice Institute
Science Club of the University of Houston
Pre-Medic Club of the Texas College of Mines

A monthly paper, called Tasca after the initial letters of Texas Academy of Science Collegiate Academy, has been published in mimeograph form, various schools taking the responsibility of assembling material for each issue. These have contained news from the clubs, papers by student members, a few papers by members of the Junior Academy, and a Counsellor's corner giving announcements and articles of interest to the collegiate group. This has made the work of the Counsellor especially heavy this year.

Copies of Tasca have been sent to the participating clubs, to leading libraries in the United States, and to the science departments of the various institutions in Texas. The latter practice has resulted in the formation of three new chapters.

The Counsellor has recommended that the treasurer be authorized to appoint a member of the collegiate committee to collect the dues from Collegiate Academy members. This will make it possible to know these members. Since many students are now paying $2.00 dues, entitling them to membership in two sections of the Academy, it is becoming more difficult to distinguish collegiate members.

Since the work of publishing Tasca has more than doubled the work of the Counsellor, the students and sponsors have suggested that a managing editor for the paper be appointed by the Counsellor or by the executive Council.

In its ten years of existence the Collegiate Academy has become an effective method of interesting Texas young people in Science. It should be remembered, however, that membership in this group is constantly changing, and its success can only be maintained by continuing to have interested, hard-working sponsors, as well as an Executive Council and a Collegiate Committee that are willing to take an active interest in it.

The Counsellor hopes that the Senior Academy will publish in the Proceedings the best paper in Biological Science and the best paper in Physical Science, as a prize. As an additional prize the Academy should give memberships in A.A.A.S. to the winning students.

Respectfully submitted
Amy LeVesconte

Dr. W. P. Taylor moved that these recommendations be referred to the Executive Council with the request to follow through. The motion was seconded and carried.

Report of the Junior Academy of Science.

The Junior Academy includes the following chapters: Abilene, Austin, Beaumont, Brownsville, Corpus Christi, Denton, Freer, Galveston, Goose Creek, Houston, Weslaco and Floresville. A new chapter was established at Albany, Texas through the efforts of the new principal Mr. Wayne Taylor, who was a Junior Academy member in 1937. Mr. Taylor teaches three classes of science.

The financial statement by the treasurer November 30, 1946 shows a balance of $72.15. The Junior Academy furnishes its members with free subscriptions to "Texas Game and Fish."

Two issues of "Tex Sciana" were published in the spring of 1946; one by the Abilene High School, who will also edit the issue following the annual meeting in Dallas, and one by the Brownsville High School.

A regional meeting was held in the south Texas area at Kingsville, April 6. Richard Graham of Brownsville High School received the gold medal for his paper, "The Saw Beetle." The boys who participated in the Junior Academy appeared on the program of the Senior Academy which we believe to be an excellent idea for other Regional meetings. The following schools participated: Edinburg, Corpus Christi, Pharr-San Juan, Freer, Alma and Brownsville. A similar plan was carried out in Abilene and Charles Tandy was presented with the Academy gold pin for his laboratory study of "Injections of the Circulatory Systems of Higher Animals."

The chapters of the Junior Academy express their appreciation to the members of the Senior Academy for their continued interest and support; however, perhaps by some oversight, no contribution was made to the Junior treasury during this scholastic year. Might not the Senior Academy through cooperation in contacting science teachers, assisting in publicizing the Junior Academy work and by suggesting projects, work to mutual profit.

Respectfully submitted
Grete Oppe, Chairman

The report and suggestion of the Chairman of the Junior Academy were enthusiastically endorsed by motion seconded and carried.

Report of the Publicity Committee.

Owing to the severe limitations placed upon newspapers and other publications as to paper, it was not possible to give the Academy as much publicity as in former years. However we succeeded in getting the Associated Press to carry stories of the annual meeting in Dallas and in small papers throughout the Southwest. The Dallas News and Times-Herald carried stories with names and subjects and photographs of featured speakers.

Throughout the year the publicity committee has supplied various papers with articles and items about the Texas Academy of Science. Considering the shortage science has fared rather well. From time to time science has been injected into the Saturday radio programs, which brought numerous requests for information.

Much might be accomplished if The Academy issued a regular news sheet to keep people interested.

Respectfully submitted
Victor H. Schoffelmayer
Chairman

Report of the Committee on Necrology.

Members of the Texas Academy of Science who passed on during the year are as follows:

Dr. A. Judson James of Houston died August 1946
Mr. H. J. Curtis of Dallas died August 27, 1946
Mr. Charles K. MacDonald died February 24, 1946

Respectfully submitted
Oscar Ullrich, Chairman

The report was accepted.

Report of the Resolutions Committee.

A. Courtesy resolutions:

1. Be it resolved that the Texas Academy of Science express its thanks to the Adolphus Hotel for the accommodations furnished, to the press for its coverage of the sessions, to V. H. Schoffelmayer and Wayne Longnecker for the publicity they gave to this session, to the Local Committee, particularly its chairman, Dr. E. P. Cheatum and his colleagues, Dr. Joe P. Harris, Jr., to the officers of the Academy, and to all speakers who appeared on the program.

2. Be it further resolved that The Texas Academy of Science express its thanks to the Texas Regional American Chemical Society for its cooperation in this, the Semicentennial meeting of the Texas Academy.

B. Policy resolutions:

1. Whereas the routine and clerical work of the Texas Academy of Science may be further improved by the elimination of duplication of effort and wasted motion and by the securing of a better continuity of policies,
Therefore, be it resolved that the Board of Directors in consultation with the Board of Development be empowered to employ a salaried assistant to the Secretary-Treasurer, the same to be known

as the Executive-Secretary, as soon as the financial condition makes this possible.

2. Whereas it has been a policy of long standing of the Texas Academy of Science to promote the conservation of all natural resources of Texas for the benefit of future generations, and whereas the construction of channels, fills and other projects in the coastal waters of Texas has resulted in the destruction of marine resources, and whereas the proposed construction of dirt-filled causeways across the lagoons in the coastal area, particularly the Laguna Madre, may result in further destruction of marine life, and consequently wild-life such as birds,

    Therefore, be it resolved that the Texas Academy of Science disapprove the construction of any project, such as dirt-filled causeways, without prior investigation by competent authority of the effects of such projects on marine life and without the recommendations of the United States Fish and Wild Life Service and the Texas Game, Fish, and Oyster Commission.

Respectfully submitted,
Oscar Ullrich
Walter Taylor
Leo Murray

These resolutions were adopted unanimously.

Report of the local committee.

The local committee on arrangements secured the Adolphus Hotel for the meeting, providing the necessary rooms and apparatus, a corridor desk for registration and some local talent for entertainment at the banquet. Ninety-six banquet tickets were sold to members of The Texas Academy of Science. The hotel management added a charge for tips not in the original agreement. Local expenses billed to the Academy include $40.94 for postage, telephone and telegraph plus the tipping charge of $28.20. The dinner bill of two guest speakers was also paid by the Academy.

E. P. Cheatum, Chairman

**Southern Methodist University**

| | |
|---|---|
| Frank McDonald | E. P. Cheatum |
| Ogden Baine | Walter Watson |
| Joe P. Harris, Jr. | C. A. Nichols |
| Mayne Longnecker | C. Albritton |

**Southwestern Medical Foundation**

Arthur Grollman

**Dallas Public Schools**

Landon H. Baker

The report was accepted and expense account approved.

Report of the Board of Development.

The Board of Development created during the last annual business session and subsequently appointed during the year has had one meeting in Austin as a part of the organization plan but has held no further sessions.

In the original planning the Board was probably too optimistic about its ability to delegate definite assignments of activity to men of important positions. In waiting for results from these assignments a condition of dormance has developed which has brought no tangible results. Probably if the Board is to accomplish more of the results for which it was created, it will necessarily have to assume more individual responsibility within its own membership for the materialization of the goals it has adopted.

Respectfully submitted

W. R. Woolrich
Chairman. Dec. 12, 1946

The report was accepted.

Moved by Fred Barkley, seconded by C. C. Albers that in order to make some provision in our Academy for outstanding negro scientists in this state, a committee on three be appointed by the president of the Academy to select two negro scientists of Texas to be made honorary members of the Texas Academy of Science, said honoraries to be accorded all the privileges of active members (except payment of dues) and that their membership shall continue for such time as they are residents of the State of Texas; further that the selection of two negro scientists be made annually, so long as meritorious negro scientists are without membership in the Texas Academy of Science.

The motion was referred to the Executive Council for study and recommendation to the Academy at the next annual meeting. It was moved, seconded and approved that the attention of the Chairman of the affiliations committee be called to the desirability of arranging to have other organizations such as the A.A.U.P. meet with us at a luncheon during the annual meetings.

## Frederick Byron Plummer

George Fancher, University of Texas

Frederick Byron Plummer, Geologist, Bureau of Economic Geology, and Professor of Petroleum Engineering, University of Texas, died at San Marcos, Texas, February 17, 1947. He was born at Hanover, New Hampshire, August 31, 1886, the first child and only son of Alva A. and Laura Merrill Plummer.

The Plummer family, known in the ancient records of England and Scotland, has been represented in America from almost the earliest permanent settlements in the New England provinces. Frances Plummer, with his wife, Ruth, came to America from England about 1623. Frances, a linen weaver by trade, busied himself with the activities incident to a new country, and in 1635 we find him keeper, among other activities, of the first inn to be opened in the township of Newbury, now the city of Newburyport, Massachusetts. The Plummers, descendants of Frances, although now widely distributed in the United States, continued for a century or more to live chiefly in the New England colonies. Frederick Byron was one of the tenth generation in America of this New England family.

After completing grade school and high school at Hanover, Frederick Plummer entered Dartmouth College, from which institution he received his Bachelor of Science degree in 1909, and Master of Science in 1911. He was a graduate student at the University of Chicago from 1909 to 1911, major Chemistry, 1909-'10, and Geology, 1910-'11. He was assistant in Chemistry at Vassar College, 1911-'12; instructor, 1912-'14. He was Fellow in Geology, University of Chicago, 1913 to 1915 and during this time completed work except thesis for the Doctor's degree. Preceding or during his service at Vassar he completed his first paper on geology, recorded in his bibliography as "Surface Geology of the Presidential Range, New Hampshire, 1913". During the summer of 1914, he worked with the Wisconsin Geological Survey, which, according to State Geologist Bean, he is officially credited with having been the "hardest working man" of his party. To those who knew him in later life, such a record is not surprising.

His first employment after leaving the University of Chicago was with the Roxanna Petroleum Company (now the Shell Company). After a short time in Oklahoma, he was sent into the coastal plains region of Louisiana and Texas, and in 1917 was placed in charge of the company's investigations in northern Texas, where for three years he carried on extensive investigations. In the fall of 1920 the Bataafsche Pet. Mij., a member of the Dutch Shell Group, called Plummer as consultant to The Hague, Holland. Upon completing this engagement in 1922, he returned to Houston, Texas.

In the approximately five years from the close of his association with the Dutch Shell Group in 1923 until the beginning of his work with the University of Texas, he served as petroleum engineer, Rycade Petroleum Corporation, 1923-'25; chief geologist, Texas Division, Amarada Petroleum Corporation, 1926; and consulting petroleum engineer in charge of geophysical work, Vacuum Oil Company, 1927-'28.

Professor Plummer's connection with the University of Texas began with his appointment as Geologist in the Bureau of Economic Geology, October 1, 1928. In 1930, upon recommendation of the departments concerned, he became Professor of Petroleum Production Engineering in the Engineering College, and Geologist in the Bureau of Economic Geology. His activities in these departments in the ensuing years were many and varied.

Previous to coming to the University, Plummer had interested himself in teaching. His temporary service at Vassar has been mentioned. During the spring terms of 1924 to '26, he lectured at the University of Chicago on Petroleum Geology, and during April, 1927, lectured to Geology students at the University of Texas. After coming to the University of Texas, he undertook several outside engagements. He lectured on Petroleum Geology at Northwestern University during the spring terms of 1930 and 1932. During August and September, 1938, he made geologic investigations in Santo Domingo, and from August to December, 1946, carried on studies for the Conselho Nacional de Petroleo in the Maranhao Basin of Northern Brazil.

Plummer was a prodigious worker and writer. His bibliography contains 155 entries, varying from short notes to monographic reports. Among his major contributions to the Geologic sciences are the following: Stratigraphy of the Pennsylvania Formations of North Central Texas (with Dr. R. C. Moore), 1922. Cenozoic Systems in Texas, 1933. Upper Paleozoic Ammonites in Texas (with Gayle Scott), 1937. Crinoids from the Upper Carboniferous and Permian Strata in Texas (with R. C. Moore), 1940.

Plummer held membership in many scientific societies, including Geological Society of America; American Association of Petroleum Geologists; Society of Economic Geologists; American Geographical Society; Paleontological Society, (Vice-president, 1932); Sigma Xi (President, University of Texas chapter, 1938); and Texas Academy of Sciences, (President, 1946), and Society of Economic Paleontologists and Mineralogists.

In 1918, Plummer married Helen Jeanne Skewes, Chicago, Illinois. Mrs. Plummer, an eminent micropaleontologist in her own right, has been an untiring helper to her husband, and has had a real part in the completion of his major publications.

Fred Plummer worked actively and unselfishly with many societies. He was one of a small group of members of the American Association of Petroleum Geologists who met on March 26, 1926, to consider organizing a paleontological section of the Society. The recommendations of this group were accepted by the Society, and Plummer was authorized to conduct a campaign for funds with which to initiate a journal for the proposed section. From this undertaking came the Society of Economic Paleontologists and Mineralogists of which Plummer was Secretary, 1927-'29 and Secretary-treasurer in 1930. He was a member of several student scientific societies and founder of one, Pi Epsilon. He associated himself actively with the American Institute of Mining and Meteorological Engineers, particularly in the work with students, the student section at the University of Texas, petroleum engineering education, research in petroleum engineering and the twilighted zones between petroleum engineering and geology. In this latter activity he many times served on the appropriate national committees. His annual reviews of this A.I.M.E. committee work are classics still quoted. He was a member of Sigma Gamma Epsilon and aided in the merger of the local Pi Epsilon with Zeta Chapter of S.G.E. at the University shortly before his death. He was active in Gamma Alpha professional scientific fraternity at the University of Chicago during his graduate days there. His keen interest in students is well illustrated by his zealous work with local chapter of Phi Kappa Tau social fraternity of which he was a member. A group of students organized the local chapter in the difficult days just prior to World War II. They came to Professor Plummer, sought his counsel and aroused his interest. Until his death he worked untiringly with them and it is not too much to say that the survival of this chapter is a monument to his persistence and energy. He was proud of his boys and they of him. He also was interested in civic affairs and for many years was a member of the Rotary Club of Austin.

Plummer had an active mind, constantly occupied with a diversity of subjects. His major interest was geology, but in addition to geology, he maintained a keen interest in engineering problems. His early studies in chemistry, likewise, caused him to combine chemical studies with geology and engineering. In fact he was interested in all science and had the knack of seeing utility in all knowledge. An eminent geologist stated recently in Dallas that he had been asked by the American Association of Petroleum Geologists to prepare biographical sketches of the great petroleum geologists, living and dead. He commented that in his opinion there were three great petroleum geologists of those who stand out from the crowd, Wallace Patt (living), Sidney Powers (deceased), and Frederick Byron Plummer, and that they presented an interesting contrast. He said that Powers was a great theorist, interested in the theory of the occurrence and accumulation of oil quite aside from all practicability whereas Pratt was the practical geologist largely interested in **finding** oil. But he went on, Fred Plummer was a most amazing genius, interested in theory yet not scorning application of theory for practical purposes and his activity consequently was of amazing area and scope. This unsought tribute is typical of what Plummer's colleagues in science thought of him.

He was a man of amazing activity and intellect, having inherited in full measure all the fabled qualities of his New England forbears. For example, a companion of his activity in early geophysical work in

West Texas often remarks, "Freddy always approved expense accounts for alarm clocks to get up early by and brooms to sweep the outcrops clean." He did so many things first, many of them in the twilight zones of science. For example, he was one of the first to appreciate the significance of the geothermal gradient in the earth crust and measured it in many bore holes of East Texas, thereby contributing in an important way not realized until much later, to an understanding of the geology of the East Texas oil-field. He became interested in the flow of fluids through permeable rocks and as a consequence we find him publishing important results as early as 1934. He speculated about the role of bacteria in the formation of travertine in the waste brines from the Luling oil field and this interest led to his classic work on the treatment of salt water for injection into the East Texas oil field, work which those who know credit with solving the problems and making possible the flood of oil from this field which helped win the war. Yet he profited not a penny from this work. Many other examples could be cited from his publications. Yet he is best known as a paleontologist because he was so modest and unassuming a genius, and workers in the twilight zones of science are few and publicity is scant. He demanded nothing except the right to work unceasingly.

He loved his students, especially those who participated in his researches and they loved him. Upon his death, dozens of telegrams and expressions arrived from throughout the U. S. and also from many foreign countries from his boys. He loaned many of them money to enable them to complete their education but no one heard of this except from the recipient. Nevertheless he was exacting of his students and meticulous as to details. He expected all to rival him in diligence. He truly had a great soul and personality and his like will not soon be found. His monument lies in the inspiration he provided to his many students, his colleagues and in the new petroleum engineering building at the University of Texas which was his special pride. Few men are missed so genuinely and so long by their colleagues as is Fred Plummer, a New England gentleman who became a Texan to the core. He must take special pride in having died in Texas, in the field, with his boots on, as a geologist should, and in sight of the spot he loved best in Texas. The University and the world of science misses him sorely but both are vastly richer for his unselfish labor.

# TRANSACTIONS

# The Academy Symposium on the Growth of Science in Texas

One Hundred Years of Texas Geology, Dr. E. Degolyer, consulting Geologist, Degloyer and MacNaughton. No abstract received.

The Development of Chemistry in the Southwest, Dr. E. P. Schooch Director, Bureau of Industrial Chemistry, The University of Texas. No abstract received.

## FIFTY YEARS OF TEXAS BIOLOGY

by
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1) The present Texas Academy of Science is the **third** of the name: (I) Academy of Science of Texas, founded October 27, 1880, at Austin, Texas, by S. B. Buckley and Dr. F. L. Yoakum; moved to Palestine 1882, moribund for several years, and 'died' about 1886, when Yoakum moved to Tyler. (II) Texas Academy of Science, founded at Austin, January 9, 1882, by Edgar Everhart, G. B. Halstead, A. MacFarlane, F. W. Simmonds, and T. U. Taylor; published 12 vols. of Transactions (1892-1912), and then suspended. (III) Texas Academy of Science (present one) reorganized in 1929, with many of the fellows and members of the Second Academy as members of the reorganized Academy.

2) The Constitution of the Second Academy provided originally for two formal meetings (June, at Austin; Christmas Week, at some designated place); seven "ordinary meetings" (At Austin, on first Fridays of October, November, December, February, March, April and May; and indeterminate "informal" meetings to be held on the third Saturdays of the above months, at Austin). During the years October 23, 1910 to November 29, 1912, 14 meetings were held, of which two were formal meetings, with election of officers for the ensuing year. The last president of the Second Academy was Dr. G. S. Fraps of College Station.

3) Formal work in Biology (worthy of the name, by modern standards), began at Texas A. & M. College in 1888, when Thomas L. Brunk, a graduate of Cornell University was appointed acting professor of botany and horticulture. During 1889-90, Herbert Spencer Jennings, later of Johns Hopkins, gave serious botanical courses, and conducted

fundamental investigations on the diseases of plants in Brazos County. He was succeeded in a few years by Helge Ness who for many years conducted investigations of great value on botany and plant-breeding there. Dr. Mark Francis came to Texas A. & M. in 1888, and initiated and continued valuable investigations on comparative animal pathology and parasitology.

4) Formal work in Biology at the University of Texas began with haphazard courses in 1885. In the period 1888-92, courses were offered by Robert T. Hill and F. W. Simmonds, professors of geology. The School of Geology was established in 1891, with Dr. Charles Lincoln Edwards as the first professor (1892), and Dr. Simmonds as "overseer" for two years. Edwards resigned in 1894, and his place was taken by Wesley W. Norman, who was head of the School of Biology (1894-99), and head of the School of Animal Biology in 1899, the year of his death. He was succeeded by William Horton Wheeler (1899-1903).

5) The Department of Botany at the University of Texas was organized in 1899. William L. Bray was the first professor in charge (1899-1907), and was succeeded (after a year's interval) by Dr. Frederick DeForest Heald, who held the headship from 1908 to 1912.

6) The heads of the Zoology Department at the University of Texas (within our period—1892-1912) were as follows: W. W. Norman, (1899), W. M. Wheeler (1899-1903), T. H. Montgomery, Jr. (1903-08), H. H. Newman (1908-11), and J. T. Patterson (1911 plus). The heads of the independent Department of Botany (1899 to 1912) were W. L. Bray (1899-1907), F. D. Heald (1908-12), and I. M. Lewis (1912 plus).

7) One of the most outstanding scholars of Texas—philosopher and biologist—who (outside of academic connections) presented papers to the Academy was Dr. Edmund Montgomery of Hempstead. He presented six papers (1895-1903), the last being his presidential address in 1903.

8) The following men are considered in connection with their activity in the Academy (from 1892 to 1912, in order of appearance), and their publications and students: Wesley Walker Norman (1863-99), William L. Bray (1865- ), Helge Ness (1861-1928), Mark Francis (1863-1936), C. H. Tyler Townsend (1863- ), Orlando Clarke Charlton (1854-1944), Frederick William Malley (1868-1939), William Morton Wheeler (1865-1937), John Kern Strecker (1875-1933), Joseph Daniel Mitchell (1848-1922), Oscar Melville Ball (1868-1942), Frederick William Simmonds (1853-1941), Carl Gottfried Hartman (1879- ), Thomas H. Montgomery, Jr. (1873-1912), Horatio Hackett Newman (1875- ), Dr. James W. McLaughlin (1940-1909), and Frederick Deforest Heald (1872- ).

9) During the twenty years of the existence of the Second Academy, 66 biological papers (by 28 investigators) were presented, but

only a fraction of them were printed. The following Table shows percentage-data of Institutions and papers:

| | | | | | |
|---|---|---|---|---|---|
| Investigators | 57% | 14% | 7% | 21% | 99% |
| Papers | 66% | 12% | 4.4% | 18% | 100.4% |

10) The above figures refer only to the proportions of papers entering into the transactions of the Society, and are no demonstrative index of the relative research activities of members of the various institutions during the years 1892-1912. Thus, Wheeler presented only three papers out of 25 published during the years 1899 to 1903; Montgomery only three out of 27 published during the years 1903 to 1908; Edmund Montgomery only 6 out of perhaps a score of papers and two books published from 1892 to 1907. At Texas A. & M. College, many scientific papers in the biological field were published by Mally, Francis, Ness, Sanderson in the form of Bulletins and papers in technical agricultural journals. Moreover, since the preponderating majority of the membership was concentrated in the Austin region, and since the "ordinary" and "informal" meetings were held in Austin, it was but natural that the largest number of papers should come from members of the University staff.

# ONE HUNDRED YEARS OF MECHANICAL REFRIGERATION in TEXAS AND LOUISIANA

by

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As a backdrop to the one hundred years to which Louisiana and Texas have made notable contributions to the world development of refrigeration, the events of the ninety year period prior to the century of activity in the South and Southwest will first be given in chronological order.

In 1755 Dr. William Cullen, a Scottish physician, who held consecutively the positions as Professor of Chemistry, Professor of Medicine, and Professor of Physics at the University of Edinburg, developed an experimental vacuum machine and made ice in demonstration lectures.

In 1781 Tiberius Cavallo, a physician who was born in Naples and later migrated to England, described his experiments relating to the "Production of Cold by Evaporation of Various Ethers and by Compression of Air" to the scientific groups of London.

In 1805 Oliver Evans of Newport, Delaware described the continuous circulation of a refrigerant in a proposed cycle in his treatise published in Philadelphia, "The Abortion of the Young Steam Engineers Guide."

In 1810 Sir John Leslie of Scotland, who was the Professor of Pure Mathematics at Edinburg, presented his paper, "A Short Account of Experiments and Instruments Depending Upon the Relation of Air to Heat and Moisture." In demonstrations he made pound lots of ice by utilizing a sulphuric acid drier with a vacuum pump.

In 1823 Michael Faraday, under the instruction of Sir Humphrey Davy, liquified amonia, chlorine, carbonic acid, nitrous oxide, and sulphurous acid. In these experimental demonstrations Faraday verified the predictions and calculations A. L. Lavoiser, John Dalton, and Thomas Northmore had made at the beginning of the nineteenth century. Before his death Faraday succeeded in liquefying all of the then known gases except five. These researches on liquefaction and condensation of gases lead to the subsequent use of many previously considered "noncondensable" gases for refrigeration.

In 1824 Mr. John Vallance of Brighton, Sussex, England, took out a British patent to use sulphuric acid in an absorption process. He successfully made quantities of ice for demonstration on the production of artificial cold.

In 1834 Jacob Perkins, an American, born July 9, 1766, Newburyport, Massachusetts, designed a closed cycle compressor and took out

British Patent 6662 in August, 1834. He describes it as an "apparatus or means whereby I am enabled to use volatile fluids for the purpose of producing cooling or freezing of liquids, and yet at the same time constantly condensing such volatile fluids and bringing them again and again into operation without waste." Perkins had his first machine built by John Hague of London, where he had taken up residence. This was the first power driven machine to make ice, but it was never used commercially.

In 1844 and 1845, just ninety years after Dr. Cullen's first work, Dr. John Gorrie of Apalachicola, Florida, a physician born in Charleston, South Carolina, described his new machine in the Apalachicola Commercial Advertiser. A New York Daily quipped "a crank in Florida thinks he can make ice as good as God Almighty." However, he made ice in quantity lots, served it at banquets and used it to condition air for his yellow fever patients. That machine was accepted throughout the world as the first successful machine to produce ice and condition air.

Dr. Gorrie's associates in developing his patent were residents of New Orleans, and he gave New Orleans as his address in applying for his patent, although most of his research and professional activity had been performed at Apalachicola.

In 1850 Ferdinand Carre developed an ammonia absorption system in France. In 1860 he took out patents covering this equipment in the United States.

In 1855 Alexander C. Twining of New Haven, Connecticut, and later of Middlebury, Vermont, a graduate of both Yale and West Point Military Academy, designed and operated a sulphuric ether compressor in Cleveland, Ohio, and made calculations indicating that he could produce ice for $1.83 per ton.

From this date onward three areas of the world became the centers of development of activity in the field of refrigeration.

Germany and France nurtured the new developments in refrigeration primarily for their interest in wine making and wort processing.

Australia and the British possessions gave great support to refrigeration and made many contributions to the scientific development of the industry to make it possible to ship perishable meats and process colony products.

The Gulf States of the United States were economically interested in refrigeration due to:

(a) The widening breach between the northern and southern states had developed an urge on the part of southern research men to free themselves from their dependence upon Boston and Great Lakes ice. The Declaration of the War Between the States brought this situation to one of acute necessity, and the efforts to solve the problem of adequate food preservation and ice production resulted in accelerated progress in mechanical refrigeration within the Confederacy. After peace was declared the spirit of independence from northern commercial traders was even much more pronounced and the work that had been started during the war days was greatly accelerated. This post-war development of the "sixties" in the United States received its greatest contributions from the creative men of Louisiana and Texas.

(b) The movement of meat over long distances under semi-tropical skies required that this meat be either shipped alive or slaughtered and preserved, then moved to the centers of population. Texas, like Australia, was vitally interested in ice and refrigeration for meat preservation and transportation.

In 1863 Bujac and Girardey of New Orleans and Augusta imported a Carre absorption machine through the blockade, and erected it at Augusta, Georgia. It was rated at five hundred pounds per day. The machine did emergency service during the war, and in 1866 was moved to Gretna, Louisiana for experimental use.

Just prior to this running of the blockade at Augusta, Georgia, a Carre machine was landed at Matamoros, Mexico, and operated there for a short time. Subsequently, it was moved to San Antonio, then to Austin, Texas.

Bujac and Girardey imported three more Carre machines through the blockade in 1863. They ran into difficulties in trying to make the fuel-fired generators work successfully. In the fall of 1865 Mr. D. Livingston Holden, a consulting engineer who was born in Higgensport, Kentucky, and who served as chief of the Magnetic Signal Corps with the rank of Major in the Confederate Army, purchased one of these units and set it up in San Antonio. He operated it the first season, making commercial ice, then contributed two radical improvements that made the Carre machine commercially feasible in the United States. His first improvement was to place steam coils in the generator and heat the aqua ammonia by steam heat. His second improvement, forced upon him by the bad water available in San Antonio at that date, was that of producing ice from distilled water. This gave him clear ice.

So quickly did these changes bring about public acceptance of machine made ice that for the next decade all Carre machines followed the design of Holden, and the firm of Bujac and Girardey publicly announced that Holden's invention in rebuilding the Carre absorption machine was "the development that made possible the introduction of Carre machines in large units."

Some indication of what the immediate result was, in making clear ice in San Antonio, can be gleaned from the daily papers of 1867 in San Antonio, which declared that "no less than three companies are in a position to furnish artificial ice in this city."

Another of these Carre machines was installed in 1866 in Shreveport, Louisiana. **The South-Western** of Shreveport, of May 9, 1866, announced "The Shreveport Ice Company commenced manufacturing ice at their factory on Cross Bayou last Friday." On September 12, 1866, the same paper announced the completion of the installation of a second machine that would give a total capacity for both machines of 4,000 pounds of ice daily.

The success of D. L. Holden at San Antonio was immediately reflected in an order for six ten-ton Carre machines to be build by Sylvester Bennett of Gretna, Louisiana, under the consulting advice of Mr. D. L. Holden and a Mr. H. D. Stratton of Columbus, Georgia. These machines were completed and installed in 1868, and started production for the Louisiana Ice Works in New Orleans. The president of the Louisiana Ice Company publicly announced, however, that they were licensed under both Carre and Twining patents. Just what feature of Twining's patents were incorporated in the design is not clear in his announcement.

During the same period that D. L. Holden was improving the Carre absorption machine, he was also engaged in experimenting with compression equipment. He became interested in a compression machine of Professor P. H. Van Der Weyde of Philadelphia, who employed as a refrigerant a mixture of petroleum ether and naptha, which was sold under the trade name of Chimogene. Holden acquired the Van Der Weyde patent rights in 1866, and had the first machine built by the Novelty Iron Works of New York.

He tried out his first machine in New Orleans. Another was apparently installed in Memphis, but met with flood disaster. Holden wrote in the report on his early activities that in 1867, "The only two concerns in the ice machine business in America were the Carre interests and myself."

Holden made many improvements on the Van Der Weyde machine, and in 1869 took out a patent on his own designs. By this time he had installed improved Van Der Weyde machines in Galveston, Bonham and Houston, Texas—Mobile, Alabama, and Charleston, South Carolina.

In 1871 he installed a complete Holden compression system in an abattoir operated in partnership with his brothers at Fulton, Texas. This unit was used to chill and cure beef for shipment to Liverpool. This plant at Fulton, Texas, was evidently the first mechanically refrigerated abattoir in the United States.

While the absorption machine enthusiasts were wrestling with the Carre absorption units at New Orleans, San Antonio, Shreveport, Matamoros and Austin, David Boyle was making a valiant effort to break into the compression refrigeration field.

Boyle was born in Johnstown, Scotland, on October 31, 1837. He served his apprenticeship as a store clerk in a Scottish grocery; then at the age of twenty-two migrated to Mobile, Alabama, intent on following a commercial career.

The price of ice and its scarcity with the consequent loss of perishable goods was a surprise to one who had been trained to be a frugal vendor of human foods in Scotland. It inspired him to increase his knowledge of refrigeration as applied to food preservation in his new surroundings. He inspected and watched the new developments in mechanical refrigeration in Columbus, Georgia, and New Orleans, Louisiana, and was much disturbed when the early experimental Carre machines tested did not prove practical. Eventually, he sent his savings to England with an order for machine that had been described in the trade literature as being successful in Great Britain.

After a long wait it became evident that this machine was not as available as the literature had indicated. He found it necessary to sue for the return of his money. When he had recovered his payment he moved to California to build two experimental machines of his own. He had made an intensive study of another inventor's models that had failed, and this together with his experience in attempting to purchase a European-type machine, made him no longer a novice. However, he set out to study further in California libraries all of the known literature on mechanical refrigeration, and also to inspect some new machines in process of development on the west coast. With this background he incorporated the most modern ideas into his experimental machines.

His stay in California lasted from 1869 to 1872. While his experimental models were not considered successful, they did give him sufficient basis for a patent application, and he was awarded U. S. Patent No. 128,448, on June 25, 1872.

Late in 1872 Boyle moved back to New Orleans to start the construction of a one-ton ammonia compression plant. Although it was not completed by the spring of 1873, he moved the partially built machine to Jefferson, Texas, arriving there about the first of June, 1873. Jefferson then was a thriving frontier river port and the principal point of dock delivery of North Texas from boat to rail, for all points west and vice versa.

Mr. Boyle made arrangements to install his machinery adjacent to a sawmill where steam power would be available. Throughout the summer he worked night and day completing his machine and with the help of the machine shops of Jefferson and Nacogdoches, Texas, put the plant in production in a lean-to of a lumber mill. His first commercial ice was produced in October, 1873.

The winter of 1873-74 was spent in adjusting the plant and putting it into better mechanical condition. When the plant was again started in the spring of 1874, it is reported to have produced a very high grade of transparent ice. This attracted a number of midwestern men who were interested in finding a satisfactory machine for ice manufacture that might be built in available American shops. This first Boyle machine, however, was lost in a fire in the summer of 1874.

In August, 1874, Mr. Boyle was called to Quincy, Illinois, by Mr. W. B. Bushnell, to build two more machines similar to the Jefferson installation. Both of these were supplied to Texas firms by Bushnell and Boyle, who had formed a partnership known as D. Boyle and Company, which relationship existed until 1878, when the Boyle Ice Machine Company was incorporated in Chicago.

Later in 1875 Mr. Boyle and Mr. Bushnell moved their activities into Chicago, and prevailed upon Mr. R. T. Crane to build the Boyle compressors in the Crane shops. Mr. H. L. Delander, editor of the **Valve World,** and Mr. L. W. Wallace, formerly Director of Engineering and Research for Crane and Company, report that the 1876 Crane Company order records show that:

> "Two entries were made to the effect that one 1,000 pound ice machine was made for Colonel Baker and one 5,000 pound ice machine made for the Capitol Ice Company. In 1877 another entry was made for an ice machine for Richard King and E. D. Baker. In 1878 an entry shows another machine for Richard King."

One of these machines built in 1876 was on display at the Centennial Exposition in Philadelphia in 1876. The Capitol Ice Company order was delivered to the Capitol Ice Company of Austin, Texas, and made high grade ice for many years. The orders for Colonel Baker and Mr. King were for South Texas; Mr. King of the King Ranch and his coworkers were much interested in the refrigeration of meat, and in the production of ice.

The verified dates of Boyle's accomplishments indicate that David Boyle deserves much of the recognition that too often is accorded Professor Linde of Germany. Linde's first commercial machine of 1873, and the second in 1875, were installed in the Spaten Brewery of Munich. The Linde machine was not patented in the United States until 1880, or eight years after the Boyle patents were allowed by the U. S. Patent Office.

The Boyle machine had proved its worth by 1878, and those who have had the opportunity of operating some of these early machines can testify that it did it well. Boyle can rightfully be called the father of ammonia compression refrigeration in America.

### Andrew Muhl

A name that occurs very early in compression refrigeration history in Texas is that of Mr. Andrew Muhl. No report of Mr. Muhl gives any clue to his early life, but from the few available scraps of biography he apparently was employed in 1865 and 1866 with the Carre agency in San Antonio, and thus might have worked with Holden in his design of the Carre system.

There are several indications that he developed and operated one of his ether compression machines in San Antonio as early as 1867. It is most probable that one of the three ice plants mentioned in the daily press as being in commercial operation in 1867 in San Antonio was a Muhl compression plant. One brief mention in the San Antonio Herald, May 6, 1869, gives some substantiation of this assumption, for that paper reported, "We learn that Messrs. Muhl and Paggi of this city have engaged to take one of their ice machines to Austin and run it for the benefit of the people of that one-horse town. This will not interfere with San Antonio arrangements for mint juleps."

A brief description of this machine is given in the **Scientific American** of August 17, 1872. Muhl received his letters patent in 1871 and later contracted with the Columbus Iron Works of Columbus, Georgia, to manufacture and distribute his machine. In the 1911 **Columbus Iron Works Catalog** is the statement: "In 1873 the Columbus Iron Works Company entered into a contract with Mr. Andrew Muhl for the manufacture of Muhl's Patent Ice Machine using ether as a refrigerant, and during the same period erected one at Montgomery, Alabama . . . The second of these machines was put up in Cuba in 1874, but after a few years' operation the machine was found not profitable. Owing to this experience the manufacture of the machine was abandoned by the Columbus Iron Works."

From other sources it is indicated that contractual difficulties between the two parties—Mr. Andrew Muhl and the Columbus Iron Works—were fully as responsible for the termination of the manufacturing as any one factor. However, this seems to have ended the commercialization of the Muhl Compression Ice Machine.

### John M. Beath and Samuel B. Martin

In any review of the literature of refrigeration it is most noticeable that those developments which were nurtured north of the Ohio and Potomac, and east of the Mississippi, have received much more press space than inventions from the more southern and western areas. In many of the historical reviews of refrigeration the work of John M. Beath and Samuel B. Martin of San Francisco, California, is entirely ignored.

The fact that David Boyle, when he needed more information and inspiration to further his inventions, was attracted to California for one year's study in the shops and libraries of the west coast, indicates that among the men who were deeply interested in refrigeration about 1869, the west coast had some new information to impart. Messrs. Beath and Martin probably rank as the west coast leaders in this early period.

These two men constructed an ice plant in 1869, at Los Angeles, California. Whether it was in production in 1870, but was missed by the census taker, or whether it just failed to get in production until 1871, is not clear, but the fact remains it is not recorded in the 1870 census reports of ice manufacturing plants. In 1870 and 1871 similar plants were built by them in San Francisco, California, and Portland, Oregon; and they introduced the flooded system of compression.

Beath constructed an absorption ice plant in Chattanooga, Tennessee, in 1872. This plant operated successfully and resulted in Beath taking out three patents covering his improvements of the absorption process. He then organized the North American Ice Company and built absorption units at Galveston, New Orleans and Atlanta, in 1875.

Beath thus became a resident of the Southwest, and spent many years developing ice plants in this cradle area of the ice business of the American continent. Beath's technical, inventive and managerial ability was demonstrated in many of his activities. He was one of America's best. His inventions, both before and after his migration to the Southwest, were of a very high order.

### Thomas L. Rankin

A close friend of D. Livingston Holden was Thomas L. Rankin, an Ohioan, who did most of his early creative work in Texas and Louisiana.

Thomas Rankin probably displayed the most versatile refrigeration activity of any of his contemporaries. He is reported to have taken out twenty-four patents in that many years after 1868. Many of these were related to the absorption process. Rankin's early work was in Dallas, Denison and other Texas towns. He was interested in the refrigeration of breweries, ice houses, meat packing plants and refrigeration cars. His absorption system was so successful that it was adopted for the Jacob Ruppert Brewery of New York City in 1897. The Ruppert Brewery was a show place for large numbers of visitors after the installation of the system. While it is generally indicated that the refrigeration system was the center of attraction, more conservative observers expressed the belief that the cold beer, and not the system, was the real attraction to visitors.

Thomas Rankin's first refrigeration patent was granted him March 28, 1876. It was a complete absorption system ice machine, U. S. Patent No. 175,498. Later, he adapted it to boats, breweries, ice rinks, cold storage and ice plants.

Rankin's greatest contribution in Texas was to develop a refrigerator car and abattoir service at Denison and Dallas. In the **Denison Daily News** of July 20, 1872, we read, "It has been known for some time that a project was on foot for the organization of a company under the title, "Refrigeration Cars Quick Transit Fresh Meat Company" for the purpose of slaughtering beeves on an extensive scale, and transporting the fresh meat in refrigerating cars direct to New York City. Mr. T. L. Rankin and Mr. F. A. Hyatt, of Denison, have been actively engaged for some months organizing the company and perfecting necessary arrangements. They have just returned from New York where they met with every encouragement."

The **Galveston Daily News** of November 30, 1873, gave a report on the Texas and Atlantic Refrigerating Company of Denison, Texas, a release by that company of November 26, 1873: "Today was inaugurated in this town the operations of the Texas and Atlantic Refrigerating Company, an organization intended to convert the beeves of Texas into fresh meat suitable for the New York market. In short, to take a steer of a suitable age from the Texas prairies and place it in a proper condition to satisfy the most fastidious taste on the tables of the Astor House, New York, all in the short space of four days. As the name of the company will indicate, ice is at the basis of the operation. The facts herein narrated were gathered by the writer from the intelligent and courteous gentlemen who have charge of the enterprise.

This is the first effort yet made in the United States to transport beef under the refrigerating process any considerable distance, hence, its success may be claimed as in some sense due to Texas, through the enterprising gentlemen who have not long been residents of our state."

A follow-up on this same release might be of interest. **The Galveston Daily News** of December 12, 1873, states: "We rejoice at the success of the experiment of the shipping of fresh beef in refrigerated cars from Texas to New York. The telegraph reports that the meat arrived in good order and sold readily at six cents per pound . . . a result which is doubtless satisfactory both to shippers and consumers. The business is said to be on a sure footing. Ninety-nine cars are to be built immediately for the purpose of extending the operations of the enterprising company which has inaugurated the business, and three trains a week are to be run on passenger time."

This development of Thomas L. Rankin and his associates spread to other beef-raising centers of Texas.

### Francis V. De Coppet

Francis V. De Coppet was a native of New Orleans who developed an early interest in refrigeration. De Coppet worked under the direction of Bennett in the building of Carre machines used in the Louisiana Ice Manufacturing Company, in 1868. Incidentally, this same plant was also Rankin's first glimpse of an ice-making machine. Throughout his life De Coppet remained an active inventor and developer of absorption units and employed many of his own patents in ice and brewery refrigeration. He obtained several letters patent, his first patent applied to absorption units, being issued on October 20, 1847. De Coppet became financially interested in the refrigeration activities of New Orleans, and remained there throughout his life.

Some of the developments of Francis V. De Coppet in absorption refrigeration were the basis for the organization of the Cincinnati Ice Machine Company that later became the Blymeyer Company of Cincinnati. In his small booklet entitled, "Sixty Years of Ice" Charles A. Zilker reports that the two leading manufacturers of absorption units in the United States, in the early eighties, were the Blymeyer Company of Cincinnati, and the Columbus Ice Machine Company of Columbus, Georgia. This is of considerable interest since the Columbus Ice Machine Company absorption machines were the product of H. D. Stratton, and the Blymeyer machines were the products of Francis De Coppet, and both of these men received much of their initial experience building Carre machines under Sylvester Bennet and D. Livingston Holden in New Orleans in 1868.

### H. D. Stratton

Since H. D. Stratton received much of his early experience in refrigeration in New Orleans, his contribution to refrigeration should be mentioned here.

Tradition has him, as a young man, doing considerable work in the Franklin Institute, Philadelphia, and especially interested in the new processes of refrigeration. When he completed his study at Franklin Institute he moved to the South, intent on participating in the new field of absorption refrigeration in this area where it was urgently needed.

Dr. Frederick A. P. Barnard, President of Columbia College, had been called upon to make a full report on the Carre Absorption Machine then on display at the Paris Exposition, this report to be for the United States Government. Stratton is reported to have made a very extensive study of the Barnard report. Since the United States Carre patent was dated October, 1860, and its use in France predated this by some years, he foresaw the day when the French-controlled patents would expire and more modern designs would find a ready market.

After his arrival in Georgia, Stratton had some opportunity to observe some of the original Carre machines that had been brought into the Confederate States during the blockade period. Both Columbus, Georgia, and Augusta, Georgia, were experimental grounds for these early machines.

Like C. M. Holden, these early experiences made Stratton somewhat of an authority on absorption machines. When Holden at San Antonio, and Stratton at Columbus, had made several improvements on the Carre machine, it was only logical that the Louisiana Ice Manufacturing Company, in preparing to erect six ten-ton Carre machines in New Orleans, should employ both H. D. Stratton and D. Livingston Holden to assist in this major absorption refrigeration installation. Mr. W. A. Taylor, in reporting the history of this plant in the **New Orleans Times Picayune** of January 25, 1937, states: "The plant was built by a Mr. Blaffer, under the supervision of a Mr. Stratton of Georgia, a pioneer refrigeration engineer."

However, in D. Livingston Holden's report on the building of this same plant, he refers to his own work on this plant under the direction of a Mr. Bennett, and he does not mention the name of Stratton. It is most likely that both Stratton and Holden were the consultants on this job.

H. D. Stratton acquired patents on his absorption system design in 1876, and is reported to have built his own plant in Columbus with a capacity of three tons in 1878. The Columbus Iron Works was then under contract with Andrew Muhl to build and install the Muhl Ether Compression System. The disagreement on the contract between Mr. Muhl and the Columbus Iron Works ended the association of these parties, and in 1883 the Columbus Iron Works united with Mr. H. D. Stratton in the manufacture of the Stratton Absorption System.

The Stratton System was made up of vertical units with a liberal capacity. They performed excellently. Many of these machines proved themselves more satisfactory than the Carre machines of French design. Some six hundred machines of this type were eventually placed by the

Columbus Iron Works. The writer can report the testing of one of these machines in 1925; it was then reputed to be in its thirty-eighth year. It was still capable of making ice at its rated capacity, and functioned so well that occasionally the operator carried the absorption machine and a companion compression machine on the same receiver.

Mr. Stratton sold his interest in 1888 to the Columbus Iron Works. Very strangely, however, for some years after this the issues of **Ice and Refrigeration** carried virtually identical advertising for the Columbus Iron Works and for the Southern Ice Machine Company, the one of Columbus, Georgia, and the other of Chattanooga, Tennessee. While both companies were using the same photographs from which to make their advertising copy, the Columbus Iron Works was the only one that made claim to being the successor to H. D. Stratton and Company.

No information on Mr. Stratton was obtainable from the Georgia Historical Society after this date of 1888. The next mention the writer has been able to find in any published journal is that H. D. Stratton, J. R. Keller and W. S. Ware incorporated the Stratton Ice Works at Pensacola, Florida, during the season of 1901, for $20,000.00.

The engineering profession of the United States and the historical societies of Georgia and Pennsylvania are remiss in not giving more recognition and historical space to the achievements of H. D. Stratton as a creative pioneer in absorption refrigeration.

### Henry Peyton Howard

A most versatile and capable contributor and organizer of refrigeration of meat in early Texas history was Dr. Henry Peyton Howard.

Dr. Howard was born in Washington, D. C., May 29, 1829. He came to Texas in 1846 with a special message from the War Department at Washington, to General Wool, who was heading a campaign for the United States, in Mexico. He joined General Wool in Mexico just prior to the Battle of Buena Vista, and distinguished himself in that decisive battle.

He returned to Washington to study for his degree in medicine, prior to settling as a permanent resident of San Antonio. He continued the practice of medicine with that of commercial enterprise and was a co-partner with Mr. Ogden in setting up an Ox-cart Transport Line from Indianola to San Antonio. During the War Between the States he was Director of Medical and Food Supplies for the Second Mississippi Division of the Confederate Forces.

His great interest in food preservation caused him to purchase from Wilson Bray of New York, the Texas rights on the Bray process of meat refrigeration. He purchased, in 1868, the steamship Agnes, fitted up a cold storage room 25 x 50 feet in New Orleans, then proceeded to make the Agnes a refrigerator ship, and in July 1869, shipped thirty beeves from Palacios and Indianola to New Orleans. The Daily Picayune, July 13, 1869, the Tri-Weekly State Gazette at Austin, of

March 23, 1870, and Flakes Bulletin of Galveston, July 13, 1869, all reported the shipment a great success.

Whether the Agnes of Henry Peyton Howard, or the William Taber, under the superintendence of Mr. T. S. C. Lowe, of balloon fame, was the first to ship beef by refrigerated boat in the United States, has been a matter of difference of opinion. Evidently, both were energetically engaged in developing their respective procedures during the same years. Professor Lowe was an exponent of carbon dioxide refrigeration. Dr. Howard was convinced that the Bray procedure was more practical.

The Taber of T. S. C. Lowe was an unfortunate selection of a boat as it drew too much water for the Gulf ports, and carbon dioxide refrigeration had its limitations since its very low temperature gave considerable threat of freezing the meat; a meat treatment then considered undesirable.

The Agnes of Dr. Howard did deliver its cargo in very excellent condition to New Orleans, and its July, 1869, cargo of Texas beef was used in the hospitals and hotels of New Orleans after delivery to Dr. Howard's cold storage room in that city. To Dr. Howard must go the honor of completing his objective and furnishing the meat from the Texas port to the tables of New Orleans by the refrigeration process first. Although his subsequent shipments of beef met with disaster, due to the loss of his shipments in Gulf Coast storms, these failures were not chargeable to the procedure.

To Dr. H. P. Howard, Texans can definitely point as the man who not only originated, but continued to develop, the refrigerated beef shipping processes for the Southwest until Texas beef took its rightful position on the tables of the United States and Europe.

Dr. Howard died in Dallas, Texas, in 1913, and was buried in his home town of San Antonio.

### Charles A. Zilker

Probably the man who best represents the refrigeration engineers' determination to produce ice with the machines made available by Carre, Holden and Boyle, was Charles Zilker.

Mr. Zilker was born in New Albany, Indiana, May 19, 1862. He learned the trade of a cabinet maker, then came to Texas in 1880, and secured a position operating a one-ton Carre plant owned by Mr. Joseph Brunet. This one-ton plant had replaced the one thousand pound Carre ice plant that had had the itinerant history of operating before the War Between the States, at Matamoros, then subsequently at San Antonio and Austin. At the time Mr. Zilker came to Austin, the 1,000 pound machine was operating at San Saba after it had made brief stops at Belton and Lampasas.

After two years' experience operating the Austin plant he accepted a position as engineer with Captain King at Brownsville, to operate the

Boyle compression plant purchased at the Centennial Exposition at Philadelphia, in 1876. Mr. Zilker was familiar with this machine by his contact with the Capitol Ice Company at Austin. As mentioned before, the first Boyle machines made by Crane and Company went to the Capitol Ice Company of Austin, and Mr. King of the King Ranch.

Mr. Zilker returned to Austin in 1884 and operated a new absorption machine that had just been installed for Mr. Brunet. He became convinced of the possibilities of absorption refrigeration, and at the age of twenty decided to go to Washington University, St. Louis, to study engineering before going into business for himself.

His brother, Andrew Zilker, and Col. Breckenridge prevailed upon him to join them in a company to make ice. They contracted with Mr. Lee of the Lee Iron Works of Galveston, in 1885, to build them a plant to be patterned after a new absorption plant that had just been delivered in Galveston by Krupp Iron Works.

Mr. Zilker told the writer that, from that time, and for many years thereafter, he built and paid for one absorption ice plant every year from the proceeds of the plants established previously. After building a number in Texas he moved eastward to Louisiana, Mississippi, Alabama and Georgia; then started northward and was successful until he tried Pittsburgh. He discovered he was too far north for profitable ice making, thus he disposed of his Pittsburgh property and turned southward again.

In 1928 Mr. Zilker sold his ice plant holdings to the Insull "Empire" for $1,000,000.00 cash. The purchasers tried to encourage him to become a vice president of the "Empire" by buying one million dollars of stock in the company. His answer was, "In other words you want me to put up one million dollars to buy my own plants . . . Gentlemen, if you are interested I will accept one million dollars cash on the barrel head and you can keep the vice presidencies." He received his money in cash as requested. Some months later the Insull Corporations went into bankruptcy.

Mr. Zilker passed away in San Antonio, Texas, May 18, 1945. He was active in the advancement of refrigeration until the very last. Just a few months before his decease the writer was fortunate in prevailing upon Mr. Zilker to write a brief history of his life in Texas. This is one of the only written documents that furnish a connected history of the development of ice refrigeration in the very area that gave to the industry the world's principal creative developments in ice making.

Complementary to the struggle for refrigeration for cooling air and water, and for the preservation of foodstuffs, has been the work of two of the founders of Texas who contributed much to solving the food problems of the Southwest. The one, Mr. Gail Borden, was the first to give tireless effort to concentration of foods; the other, Mr. George W. Fulton, to encourage the expansion of meat packing facilities to place Texas meat on eastern markets. Both of these men expressed intense interest in expanding the refrigeration industry as a solution to the food preservation of the Southwest. A brief history of these two men, therefore, is included in this paper on refrigeration and food preservation.

## Gail Borden

From the dawn of Texas history until the present day, the preservation of food, so that it could be stored or transported, has been a major scientific problem of the Texas Commonwealth. It is an interesting fact that the first man who proved eminently successful in this activity was also a prominent land surveyor of the "Old Three Hundred." It might be remembered that the Old Three Hundred acquired their title by migrating with Stephen F. Austin to take up the first colonization "labors" and "leagues" from the Mexican Government. This man who so effectively distinguished himself was none other than Gail Borden, known principally to the present generation for his contributions to the art of milk processing.

Mr. Gail Borden was probably one of the closest men to Stephen F. Austin of the entire colony. Borden and Austin were both deeply religious and severely earnest in their undertakings. Both had a patience, a persistence and a practical philosophy of life that enabled them to accomplish many seemingly impossible jobs.

Borden was born in Norwich, New York, November 9, 1801, a descendent of Roger Williams. The family moved to Southern Indiana when Gail was fifteen years old. Since he was not a strong physical specimen it was decided early that at a convenient time he should try out the climate of the deep South.

Together, with his younger brother Thomas Henry Borden, they arranged, when Gail was twenty-one and Henry eighteen, to pilot a trading raft from Indiana to New Orleans. It was on this trip, in New Orleans, that the Bordens met Stephen F. Austin and arranged to join his initial colonization party to Texas. While Gail spent a period in Mississippi gaining new health, the younger brother went on to Texas. When Gail joined the Texas colonist he was engaged at once in surveying, an art he had learned in Indiana and practiced also in Mississippi.

The Bordens fought in the battles for the independence of Texas, printed the only newspaper of the Colony, and maintained the land records for the colonists of Texas. Gail was later appointed as Collector of the Port of Galveston for the Republic of Texas.

In Galveston he set to work to make a satisfactory meat extract so that Texas beef could be readily marketed. He produced and patented the first successful meat extract and meat biscuit in the world. He was awarded international tribute for this accomplishment, but was never able to make a commercial success of his process. He turned to concentrating milk.

He was in the North at the time of the declaration of War Between the States. He had been called there to follow through his patent application and establish the validity of his claims. He had a small milk condensing plant for demonstration purposes in a Shaker Colony in New Labanon, New York. He had just completed his demonstration to the Commissioner of Patents and had received his patent award when war broke out. Immediately, unexpected orders came to him from the War Department, and by the time he was able to return to Texas to join his many relatives who were in the Confederate Army, the Borden Condenseries had become an established institution and Gail Borden was able to pay his many obligations made during the years when he attempted to sell Texas beef in concentrated form.

Gail Borden died in Texas, January 11, 1847, at his old home at Harvey Creek, more commonly called Borden, Texas, nine miles west of Columbus on the Southern Pacific Railroad.

**George W. Fulton**

Not many years behind Gail Borden trailed another man of engineering bent. He was George W. Fulton.

Mr. George W. Fulton, Sr., was born in Philadelphia, Pennsylvania, June 8, 1810. His parents were George Fulton, a native of Scotland, and Mrs. Ann Ware Fulton, a native of Delaware.

Fulton was educated in the schools of Philadelphia—then learned a trade as a watchmaker and mathematical instrument maker.

He emigrated to Montezuma, Indiana, at the age of eighteen, and successfully tried his hand at sign painting, school teaching and bookkeeping before turning to his watchmaking trade. He set up a shop of his own at Terre Haute and later, at Vincennes.

When he heard of the invasion of Texas by Santa Anna he organized a company of sixty men in 1836-1837, and joined Copano Miller's regiment in Indiana. They joined the Texas army in March, 1837, and served until June, when the Texas army was disbanded.

He was assistant to John Borden, the first land commissioner—then turned to land surveying with Henry Smith, later Governor of Texas. In 1838 he was appointed Collector of Customs, by President Houston.

When Texas joined the Union he moved to Baltimore to educate his children. He became interested in railroading and held positions from railroad editor to general superintendent of several different railroads.

In 1865 he was named Assistant Engineer under John A. Roebling, to build the first suspension bridge of the world, at Cincinnati.

He returned to Texas in 1867 and located at Fulton on Aransas Bay. Aransas Bay became one of the important cattle processing centers of the United States, and George Fulton and his two sons-in-law, E. G. Holden and C. M. Holden, were most active in the promotion of meat processing.

Mr. Fulton died in Texas after he had developed a cattle empire in his own right.

Texas and the Southwest needs to give more time to the historical research on the lives of many of these men who did so much for the development of this area, but whose work came at a time when the national press was antagonistic to recognition of southern accomplishments, and the southern press was either too poverty-stricken to print more than a few local items daily, or—in many cases—was entirely silent because it had been destroyed by opposing forces.

There are many interesting biographical records that should be reclaimed from the scant news items and reports in our library files of the Southwest. When more of this is brought to light it will become more evident that the Southwest had many men of creative scientific achievement whose records have passed too nearly into oblivion.

To summarize our observations the writer would re-emphasize the following:

1. In the field of air conditioning and refrigeration for human comfort and medical aid, Apalachicola, Florida, is the recognized birthplace. Dr. John Gorrie was the pioneer in this type of refrigeration and, with his associates from New Orleans, made the first successful application of refrigeration to public health.

2. The work of D. Livingston Holden in re-designing the Carre machines at San Antonio, Texas, made possible the opening of the first Carre ice plants to be operated on a commercial basis. The Carre system was not applicable to the mass production of ice until Holden's improvements had been made.

3. In the development of refrigeration for the production of artificial ice, Texas and Louisiana constituted the world cradle of mass production of ice.

4. Mechanical refrigeration was first applied to the packing house business in the United States by D. Livingston Holden, in a plant owned and operated by the Fultons and the Holdens, at Fulton, Texas.

5. The first experimental compression machines using ammonia as a refrigerant were built by David Boyle of Mobile, Alabama, at Berkley, California, and John M. Beath at San Francisco and Los Angeles, in 1869 and 1870. While Beath built similar plants in San Francisco and Portland, Oregon, he subsequently abandoned the compression for the absorption system. The Boyle commercial ice plant built in Jefferson, Texas, in 1873, introduced a prototype of the ammonia compression machine that was destined to be the principal competitor to the aqua ammonia absorption systems for the next half century. David Boyle can be rightfully called the father of ammonia compression refrigeration in the United States, and Jefferson, Texas, is accepted as the birthplace of this development.

6. The initial research and development work for the concentration of beef and milk was done by Gail Borden, one of the founders of Texas, in Galveston, Texas.

7. The first refrigerated shipping of meat by boat was successfully carried out by Dr. H. P. Howard and Wilson Bray, in a cargo shipment of thirty boxes delivered from Palacios, Texas, to New Orleans, in the first week of July, 1869.

8. The Texas Academy of Science could make a great contribution to the industrial history of the Southwest by obtaining more complete biographies of the men who have made great contributions, but due to the lack of technical publications in the area, have never been given proper recognition for the work they have done.

(1) Life of Dr. William Cullen—Thompson, Thompson and Craigie—William Blackwood and Sons—Edinburgh, 1859.

(2) Institution of Civil Engineers, Minutes of the Proceedings—Vol. 58: 179, 1882.

(3) Philosophical Transactions—Vol. 71: 509-520, 1781.

(4) The Abortion of the Steam Engineers Guide—pp. 311-314, Philadelphia, 1805.

(5) Mechanics Magazine—Vol. 1: 136-139, 1824, London.

(6) Newton's London Journal of Arts and Sciences—Vol. 8: 251-253, 1824.

(7) Life of Richard Trevithick—Trevithick, Vol. 2: 294-295, 1872.

(8) Jacob Perkins by G. and O. Bothe Historical Society of Pennsylvania, Philadelphia, pp. 149-151.

(9) History of Refrigeration—Ice and Refrigeration, Vol. 67: 430, J. C. Goosman.

(10) The Daily Mirror, p. 2, Col. 2, May 31, 1856.

(11) The National Intelligencer—Washington, Oct. 16, 1856, p. 3, Col. 1; and Nov. 7, 1859, p. 3, Col. 4.

(12) New Orleans Picayune—June 15, 1869, p. 2, Col. 2.

(13) Ice and Refrigeration—August, 1925. History of Refrigeration, J. C. Goosman.

(14) Encyclopedia Brittanica, 11th Edition, Vol. 30, Refrigeration.

(15) Institution of Civil Engineers, Proceedings—Vol. 37: 24-246, 1873. On the Mechanical Production of Cold—Carnegie Kirk.

(16) Historical Review of the Rise of Mechanical Refrigeration—Ice and Refrigeration, Vol. 21, 1901.

(17) Ibid, Vol. 22, 1902.

(18) Gorrie Monument Unveiled—Ice and Refrigeration, Vol. 18, 1900.

(19) New Orleans Picayune—July 13, 1869.

(20) Flakes Bulletin (Galveston). July 13, 1869.

# The Banquet Meeting Together With The Regional American Chemical Society

Address of welcome—Dr. Hemphill Hosford, Dean Southern Methodist University. No abstract received.

The President's Address. Excerpts read from letters and appearing in the Proceedings. Dr. Plummer was not present.

Chemical Implications of the Development of Nuclear Energy. Dr. George Willard Watt. Professor of Chemical Engineering, The University of Texas. No abstract received.

## PHYSICAL IMPLICATIONS OF NUCLEAR ENERGY

By R. N. Little
Physics Department, University of Texas, Austin

We stand today with respect to nuclear energy in the same position as the world did with respect to electrical energy when Benjamin Franklin served his electrically cooked picnic in 1749. A new form of energy has been harnessed, but we are as little able to predict what developments will come as the scientists of that day were. A forecast of the implications of such a discovery is an essential step in the planning of a develoment program and the basis of such a forecast must be the comparison of the new with existing energy sources.

Nuclear energy is most like chemical energy. Chemical energy is obtained when two or more atoms rearrange their electronic structure to a state in which the potential energy of the electrons is less. This decrease in potential energy is liberated as kinetic energy and ultimately appears as heat. Nuclear energy is obtained when the protons and neutrons of the nucleus, the so-called nucleons, of one or more atoms rearrange themselves into a new configuration with a corresponding release of kinetic energy. The kinetic energy, however, does not come as a result of a decrease in potential energy but as a result of a decrease in the mass of the particles involved. This kinetic energy release and change of mass remained unexplained until Einstein postulated his famous equivalence formula $E=mc^2$.

The **maximum mass difference** for any present known configuration change occurs with uranium fission in which the mass decreases by about one part in ten thousand. This gives a heat of reaction of

$2 \times 10^9$ calories per gram as compared with the $10^4$ calories per gram heat of combustion for gasoline. So the first important difference is the factor of 200,000 times more energy per unit mass than for ordinary fuels.

The **second important difference** is in the nature of the by-products of the reaction. The reaction does not go in one step from uranium to the stable end products but through a series of intensely radioactive isotopes and the whole process is accompanied by a shower of free neutrons and electromagnetic radiation ranging from visible light to gamma rays. These radiations are a definite menace to living cells and are difficult to screen.

There is a **third important consideration,** the available supply of the fuel. Only two elements are known for which this reaction will spread throughout their bulk, U 235 and the synthetic element plutonium which is produced in a pile enriched with U 235. These can be diluted to some extent by materials which will fission but which will not sustain the chain reaction. Thus, our present energy sources depend on U 235, one of the rarest elements in the earth's crust. The present sources of nuclear energy then have these three distinctive properties: (1) enormous energy to mass ration, (2) scarcity of fuel, (3) great danger to man.

To the physicist these qualities point to the use of nuclear energy as power for unmanned exploratory missiles into regions which could not be reached heretofore. These regions may be interplanetary space, certainly the earth's upper atmosphere, explored by nuclear rockets or possibly the unknown interior of the earth explored by mechanical moles.

Continued development and research in the nuclear energy field may give the key to the use of other and more common elements as fuels. Knowledge of nuclear forces is inadequate to correlate even the experimental facts we now know into a unified theory. Much more study is required and perhaps the properties of the radicactive fission by-products will serve as the Rosetta Stone of nuclear physics. Many of the results we have are based on radio-active sources of very weak intensities and with the intense sources available from uranium piles the interpretation of much data may be revised radically. Probably the most important implication for physical research is the fact that the pile furnishes in such abundance these radioactive elements and the neutron and gamma radiations.

The intense neutron source is particularly valuable because of the ease with which neutrons cause nuclear reactions. A start has been made with a diffraction spectograph used to get a beam of neutrons of a single energy. These beams are only in the thermal energy region as yet but valuable data on resonance cross-sections has been obtained. These data are especially important because the theoretical ideas of selection rules for resonance phenomena have been taken bodily from the quantum mechanics of atomic spectra. This carry over may need modification especially in regard to orbital motion in view of the fact that the nucleon moves in a space of the order of magnitude of its own dimensions. Certainly the importance of these new intense sources cannot be overestimated for nuclear research.

There is a related problem which affects the continuation of physical investigation although not a problem in physics itself. The nuclear research program sponsored by the government during the war demonstrated that an exhaustive program in nuclear physics is beyond the facilities of any existing university. This is true not only of finances but also of existing arrangements for cooperation between men working in the necessary allied fields. It is still possible for a school to sponsor research of the highest grade in certain fields of nuclear physics but these fields are becoming fewer as the larger machines develop better ways of getting the same answers. The only disinterested body with enough money to finance an elaborate program in nuclear physics is the national government and we may expect it to play an ever increasing role in this field.

The nuclear energy developments which have been so spectacularly successful are based on a mass decrease of about one hundredth of one percent. There is no reason to suppose that the complete change of nucleons into radiation is impossible. It may be impossible under terrestrial conditions but only continued research into the properties of these particles will afford an answer to this interesting speculation. Of course if that secret is discovered, the new super bomb will make our present one seem like the flash of a cap pistol.

# SECTION I: PHYSICAL SCIENCES

**Program organized by W. T. Gooch**

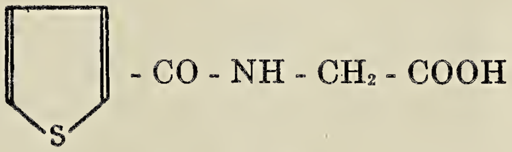
THE INFLUENCE OF HABITAT ON THE CALCIUM CONTENT OF PLANTS. PAUL LAUBACH, Southwestern University, Georgetown. No abstract.

## A MICROBIOLOGICAL SYNTHESIS OF 2-THIOPHENECARBINOL

FLOYD W. DUNN, Abilene Christian College, Abilene.

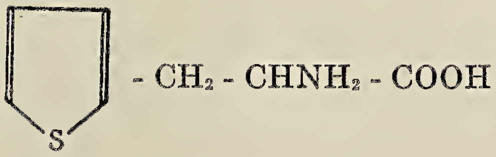
KARL DITMER, University of Colorado, Boulder

During recent years the biochemical relationships between the derivatives of benzene and thiophene have stimulated increasing interest. Erlenmeyer (1) first pointed out the isosteric relationship between the vinylene group and the divalent sulfur atom. Since that time many important compounds have been prepared wherein the vinylene group and the sulfide group have been interchanged. One group of isoesters resulting from such an exchange display the natural biological activity, where as other such isoesters produce inhibition of the normal biological processes. An example of the former type is the detoxification of thiophenecarboxylic acid in the animal body by formation of thiophenuric acid, in a manner similar to the detoxification of benzoic acid by the formation of hippuric acid (2).



Thiophenuric acid

On the other hand, when the phenyl group of the amino acid phenylalanine was replaced by thiophene the resultant thienylalanine did not behave like phenylalanine, but instead blocked some of the biological activity of the natural amino acid. Thienylalanine was found by du Vigneaud and co-workers to be a specific antagonist of phenylalanine in the growth of microorganisms, (3).



8-2-Thienylalanine

Many important organic chemicals are synthesized by microorganisms, such as bacteria, yeasts and molds. It was considered of interest to determine whether thiophene derivatives could be synthesized by these biological systems in a manner similar to the synthesis of benzene derivatives. Neuberg and co-workers (4, 5) demonstrated that a system of fermenting yeast could produce benzyl alcohol and acetylphenylcarbinol from benzaldehyde; Lintner and Liebig (6) showed that yeast acted on furaldehyde to produce furfuryl alcohol plus other furan derivatives. In this report are presented the results of studies of the effect of fermenting yeast on 2-thiophenealdehyde.

For the microbiological synthesis herein reported, a fermentation system was prepared from Budweiser yeast, sucrose and water. At the onset of fermentation the aromatic aldehyde was added, and the reaction was allowed to continue for a period of three days. Under the conditions employed in this investigation a large part of the thiophenealdehyde is attacked by the enzyme system of the fermenting yeast in a manner analogous to the reaction with benzaldehyde. Whether or not additional thiophene derivatives are produced during the course of this reaction is not yet certain.

Thiophenecarbinol was isolated from the reaction mixture by precipitation as the 5-chloromercuri-2-thiophenecarbinol derivative. The mercury could be removed with hydrogen sulfide, liberating the thiophenecarbinol.

To establish the identity of the carbinol produced microbiologically, thiophenecarbinol was synthesized from 2-thiophenealdehyde by the crossed Cannizzaro reaction with formaldehyde. This procedure, developed by Davidson and Bobert (7) as a general one for aromatic alcohols, was found to apply equally as well to the thiophene compound. The carbinols prepared synthetically and microbiologically were compared by mixed melting points of the phenylurethan and o/napthylurethan derivatives and by elementary analysis. The thiophenecarbinol produced by the fermenting yeast was found to be identical in every respect with the thiophenecarbinol prepared by chemical synthesis.

## EXPERIMENTAL

**5-Chloromercuri-2-thiophenecarbinol.**—The microbiological synthesis was carried out with a mixture of 50 g. Budweiser yeast, 50 g. sucrose, 1250 cc. water and 5 g. thiophenealdehyde. At the end of four days the yeast was removed by filtration, and 500 cc. of 5 percent mercuric chloride were added to the aqueous solution. At the end of several days, when precipitation was complete, the supernatant liquid was decanted and the precipitate washed with cold water. The yield was 5.27 g. (33.4% of the theoretical) of crude 5-chloromercuri-2-thiophenecarbinol. Repeated recrystallization from hot water produced a white powder melting at 183-185°, with decomposition.

**Analysis:** Calcd. for $C_5H_5SOHgCl$: C, 17.18; H, 1.44; Hg, 57.4
Found: C, 16.80; H, 1.42; Hg, 56.31.

The free 2-thiophenecarbinol was isolated by treating a warm aqueous solution of the mercury derivative with hydrogen sulfide, filtering off the mercuric sulfide and extracting the carbinol with ether. The o/-napthylurethan derivative of this biologically synthesized alcohol was prepared as described below. The melting point (148°) of this derivative and the corresponding derivative from synthetic thiophenecarbinol showed no depression when the two were mixed. The analysis of the o/-naphthylurethan derivative further established the identity of the isolated thiophenecarebinol with the synthetic product.

**Synthesis of 2-Thiophenecarbinol.**—Into a three-necked flask, equipped with a stirrer, dropping funnel and thermometer, were placed 3.5 g. of 2-thiophenealdehyde, 10 cc. absolute methanol and 5 cc. formalin. With stirring the mixture was heated on the water bath to 65°, at which time a solution of 6 g. NaOH in 6 cc. water was added. Heating was continued at 65° for thirty minutes, and then the solution was refluxed for a short time. The reaction mixture was extracted with benzene. Distillation yielded 2.1 g. (59% of the theoretical) of the carbinol boiling at 102-105°/20 mm.

**o/-Naphthylurethan Derivative of 2-Thiophenecarbinol.**—A mixture of equal parts of the carbinol and o/-naphthyl isocyanate was heated for thirty minutes on the water bath. After recrystallization from a mixture of chloroform and petroleum ether the colorless, monoclinic crystals melted at 148°.

**Analysis:** Calcd. for $C_{16}H_{13}O_2SN$: C, 67.78; H, 4.62; N, 4.94; S, 11.31
Found: C, 67.81; H, 4.60; N, 4.97; S, 11.30

**Phenylurethan Derivative of 2-Thiophenecarbinol.**—A mixture of a few drops of phenyl isocyanate with an equal volume of 2-thiophenecarbinol was heated on the water bath for thirty minutes. Recrystallization of the product from petroleum ether produced colorless, monoclinic crystals melting at 72.3-74°.

**Analysis:** Calcd. for $C_{12}H_{11}O_2SN$: C, 61.77; H, 4.75; N, 6.00; S, 13.74
Found: C, 61.69; H, 4.80; N, 6.13; S, 13.72

## Summary

2-Thiophenecarbinol was synthesized from 2-thiophenealdehyde by fermenting yeast in a manner similar to the microbial synthesis of benzyl and furfuryl alcohols from the corresponding aldehydes. The carbinol obtained from the fermenting yeast was identical with the 2-thiophenecarbinol synthesized from 2-thiophenealdehyde by a crossed Cannizzaro reaction with formaldehyde. Three derivatives of 2-thiphenecarbinol were prepared and described.

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## HIGH OCTANE GASOLINE SIMPLIFIED

By Sidney Lee, Vice President, Dallas Laboratories, Dallas, Texas

The act of refining petroleum has changed markedly in the past 20 years. A significant percentage of the total usable refinery facilities are only 10 years old. This change in the refining processes is largely due to the requirement that motor fuels have a high anti-knock value.

The new refining processes are directed to the production of a larger quantity of branched chain hydrocarbons.

Let us compare crude petroleum to a basket of wooden twigs. The twigs are of different sizes and shapes, but all composed of the same fundamental material. Similarly in crude petroleum all the compounds are hydrocarbon, but are of different shapes. Some are long and thin —others highly branched. It is desired in a high anti-knock fuel to have a large percentage of branched "twigs."

Engine knocking is caused by auto oxidation of the fuel due to high temperature in the compression stroke. Before the stroke is finished and the spark set off, the fuel will ignite and tend to push the pistons opposite to its forced method of travel—compression. This causes a reverberation known as knocking.

The branched twigs take longer to burn as the flame travel has to digress in many directions. They also are harder to ignite.

Petroleum follows this analogy. Branched chain hydrocarbons do not cause knocking. The processes of alkylation, isomerization, polymerization, are all directed to producing a branched chain hydrocarbon that will resist pre deterioration or knocking.

THE PLANS AND OBJECTIVES OF THE COTTONSEEDS PRODUCTS LABORATORY. C. A. WAMBLE. A motion picture without abtract.

THE HISTORY OF TEACHING PHYSICS IN TEXAS COLLEGES. S. R. SPENCER. Baylor University, Waco. No Abstract.

CO-RELATIVE RESEARCH PROBLEMS IN SCIENTIFIC CITY PLANNING. HUGO LEIPZIGER-PEARCE. University of Texas. Austin. No abstract.

## THE EFFICIENT USE OF PORTABLE FANS

ELMER G. SMITH, A. and M. College, College Station

When a portable fan is used to cool a bed room by bringing in cool outdoor air to replace the hot air in the room, the fan should be started about one hour before the bedroom is to be occupied. Efficient fan performance can be obtained only when the fan is used to blow the hot air out of the room. If an attempt is made to use the fan blowing into the room, very low efficiency results. The fan blast is roughly conical in shape and the fan should be located far enough from the outlet window so that the fan blast just fills the opening. To accomplish this a 16 inch fan should be located about 3 feet from a 24 inch square opening. If the fan is not aimed straight toward the window or is too close to it, the efficiency is greatly reduced. If the fan is placed too far from the window, the efficiency is reduced but not so seriously. More complete information can be obtained by writing to the **Texas Engineering Experiment Station,** College Station, Texas and requesting a free copy of Bulletin No. 95, entitled **The Efficient Use of Portable Fans.**

## AN ALTERNATIVE FOR N-SPACE

R. S. UNDERWOOD, Lubbock

This paper deals with the subject introduced in a pioneer article entitled "An Analytical Geometry for N Variables," published in the May 1945 issue of the **American Mathematical Monthly.** I shall omit proofs and technical details and shall try to give a brief account of some of the main results, both published and unpublished, to date.

For some time beginning in 1943 with the publication in the Scientific Monthly of my article entitled "Mysticism in Science," I have been intrigued by the idea of finding a simple and teachable (to college students) analytical geometry dealing with more than three variables. By "geometry" I mean a study of actual figures—of figures, that is, which can be represented by chalk and pencil marks for lines, and by pieces of paper, for surfaces. I do NOT mean the total abdication of geoometry in favor of algebra such as we have in the idea of 4-space, 5 space and n-space, which entails as I see it the surrender of everything geometric except the terminology. Such sallies of modern mathematicians into fields of mysticism and abstraction have doubtless borne fruit, whether or not a more down-to-earth approach might have paid greater dividends; but at least they need not be" the whole show." The type of real geometry which teams up so beautifully with algebra in the case of plane and solid analytical geometry, deserves at least a chance to make good when a few more letters come into the picture along with x, y and z.

The basic features of my plan are a set of axes drawn on a plane like the spokes of a wheel, and a system of coordinates which represent distances measured parallel to the respective axes in vector sequence. Each axis has positive and negative directions, the first being the one which points upward or to the right from the origin. When two axes are involved, the scheme is that of orthodox plane analytical geometry. The system lends itself readily to extension into three dimensions, by a special axis represented by the axle of the wheel. Thus both the plane and solid analytical geometry are included as special cases of the general plan.

In both the plane and the solid system a given set of coordinates designates one and only one point, though a given point may have many different sets of coordinates. This latter feature, which is also true of the well known polar coordinates, is not particularly objectionable; but even so the minor objection may be removed by the use of "generalized coordinates," which include in a unique set all coordinates of a given point.

In the plane case involving three variables, a single equation such as: $2x + 3y + z + 4$, in which the coefficient of **y** is the sum of the coefficients of **x** and **z**, represents a straight line; whereas in the three-dimensional analog known as solid analytical geometry, two simultaneous equations are required. The latter subject is better adapted to the study of surfaces such as those of spheres and cones; but the plane variant seems to be a better device for interpreting, in pictorial form, ideas from algebra and calculus, such as partial derivatives and the loci of equations. Two simultaneous first degree equations usually intersect in a line, just as they do in the solid case; but here the line appears directly on the plane of the paper or blackboard instead of in imagined perspective. The quadric surfaces of solid analytical geometry retain characteristic silhouetted forms on the three axis plane.

Of especial interest is the fact that, even when **more than** three variables are involved, the mathematical picture on the plane may actually be drawn. The ghostly abstractions of mathematicians known as "hyperspheres", "hyperplanes", etc. are materialized at last in a splash of lines! The locus of the equation in which the sum of the **n** variables is equated to $a^2$ turns out to be a family of ellipses contained within and completely filling, a circle of radius $(n/2)^{1/2}a$, where **n** is any integer greater than 2. The proof of this result, completed after the publication of the pioneer paper, has not yet been published.

# SECTION II: THE PHYSICAL SCIENCES

## HYDROBIOLOGICAL STUDIES IN BARATARIA BAY, LOUISIANA

WILLIS G. HEWATT, Texas Christian University, Fort Worth

During the summer of 1945 and at chosen seasonal intervals since that time, water samples were collected from Baretaria Bay. Temperature, dissolved oxygen, salinites, and pH records were taken from the samples. Quantitative plankton samples were collected from eighteen stations on the bay. Mud cores were also taken for future study.

## THE AGE, GROWTH, AND FOOD HABITS OF THE LAKE DALLAS WHITE BASS, *LEPIBEMA CHRYSOPS* (RAFINESQUE) 1940-1946

J. K. G. SILVEY, Department of Biology
North Texas State Teachers College, Denton, Texas

The age and growth of the white bass collected from Lake Dallas and Elm Fork of the Trinity River were studied over a period of six years. The fish were collected by fyke nets, seines, and were taken at various times with the permission of anglers. The food habits of the white bass may be described as being entirely carnivorous; insects, microcrustacea, and fish comprise the food material. The size of the white bass was not important if it was sufficiently large to consume other species of fish. The growth of the white bass is much faster in southern waters than in Lake Erie. Approximately 8.4 per cent of the fish caught were "young of the year", 53 per cent in the first year group, 33 per cent in the second year group, 4 per cent in the third year group, and 1.6 per cent in the fourth year group. No older specimens were taken. The scales of the white bass serve most appropriately for a study of age and growth in the region.

## THE COLLECTION OF HUMAN EMBRYOS AT THE UNIVERSITY OF TEXAS

JOHN G. SINCLAIR, Medical Branch, University of Texas, Galveston

For many years embryos have been collected and the most important specimens serially sectioned at the Medical Branch of the University. To date we have 60 series. The earliest start at 15-day, 17-day, and 26-day embryos, too small to be measured except on the slide. Then come two 3.5 mm. embryos and a closely graded file of crown-rump lengths up to 60 mm. Larger embryos are sectioned only at intervals or samples are taken through particular organs.

Embryos are obtained through several means. Abortuses are almost invariably either abnormal or die and macerate some time before abortion. They are of little use for microscopic study. The routine examination of uteri removed for various reasons, i.e., fibroid tumors, occasionally disclose unsuspected early pregnancies. The 26-day embryo was obtained in this way. The earliest and most normal embryos are obtained in cases of ectopic pregnancy, generally unsuspected, and discovered when the patient is operated upon for appendicitis or is explored for poorly defined symptoms indicating a pelvic tumor.

The function of such a collection is to serve for reference in researches on the origin of organ systems or other specific tissue differentiations. It becomes evident in studying anomalies of development that most of them begin very early and most of them have a genetic basis. This concept must be modified by the recent knowledge that virus diseases early in pregnancy produce a large number of severe defects.

## THE HISTOLOGY OF ANURAN LIMB REGENERATION

JOHN W. FORSYTH, Texas Christian University, Fort Worth

The capacity to regenerate a hind limb is lost during the early metamorphosis of anuran larvae. Histological changes in the stump of the amputated hind limb of the **Rana sylvatica** are described for (1) tadpoles showing complete normal regeneration of the hind limb, (2) those which have completely lost the regenerative capacity and (3) those in the "critical stage" where regenerative changes begin but never go to completion. The period at which regenerative capacity is lost is correlated with the morphological and histological characteristics of the limb at the time of amputation. Preliminary observations on cell densities and mitotic indices of the three types of limb stumps are included in the discussion.

## THE NEMERTEAN CARCINONEMERTES AS AN INDICATOR OF THE SPAWNING HISTORY OF THE HOST CALLINECTES SAPIDUS

SEWELL H. HOPKINS, A. and M. College, College Station

**Carcinonemertes carcinophila** (Kölliker, 1845) on the gills of mature female crabs which have never spawned are always small, light-colored and immature, but on the gills of crabs which have spawned these nemerteans are always large and deep red in color. Crabs which have spawned in the past can be distinguished from those which have not spawned by inspection of the nemerteans on the gills which the unaided eye. About 97 per cent of the spawned female crabs in lower Chesapeake Bay have **C. carcinophila** on the gills.

SOME PROBLEMS OF MARINE BIOLOGICAL RESEARCH IN TEXAS. J. L. BAUGHMAN. Game, Fish and Oyster Commission of Texas. Rockport. No abstract received.

## A HITHERTO NEGLECTED INTEGUMENTARY GLAND IN THE TEXAN TORTOISE

HOBART SMITH and SIDNEY O. BROWN
A. and M. College, College Station

The Texan tortoise, **Gopherus berlandieri,** possesses a pair of glands on the ventral surface of the head near the angles of the lower jaw. We designate them the **subangular glands.** While briefly noted by a few other authors, their occurrence generally has been overlooked and their histology completely neglected.

Each in males is a symmetrically rounded eminence of about the same diameter as the eye. It is vestigial and non-functional in females. A hedonic rose is implied.

No other member of the genus **Gopherus** possesses a similar gland. The structure accordingly lends emphasis to the distinctiveness of the species, formerly of dubious status. In the related genus **Testudo,** from which **Gopherus** was presumably derived, an analagous gland does occur, however. On the basis of this feature **G. berlandieri** is indicated to hold a primitive position in relation to other species of its genus.

Histological preparations from males reveal that the glands are imbedded in the corium of the integument and are surrounded by a capsule of connective tissue dividing the organ into lobes. The glandular tissue consists of flattened epithelioid cells of holocrine type arranged in lobules, near the central cavities of which disintegration of the cells is evident. The glandular cells, similar to the sebaceous gland cells of mammals, apparently arise by proliferation of the basal layer. The glands are connected with the surface by one or more very short ducts bounded by squamous epithelium. Some columnar epithelium apparently of the apocrine type is present.

In females only a degenerate capsule of connective tissue is present.

## NEOTENY IN TEXAS SALAMANDERS

HOBART M. SMITH, A. and M. College, College Station

Ten years ago only one neotenic plethodontid salamander was known in Texas: **Typhlomolge rathbuni,** the blind salamander from artesian waters about San Marcos. Now four others are known. All belong to the genus **Eurycea,** and are endemic to the Edwards Plateau area. First to be described (1937) was Bishop and Wright's **E. neotenes** from Helotes; next (1941) was Bishop's **E. nana** from San Marcos; and this year two others have been distinguished (**E. latitans** Smith and Potter from Cascade Caverns, and another not yet named).

Differences between these species are chiefly internal, revealed by study of alizarin-stained and cleared specimens. Fortunately a few external characters are evident and serve to distinguish specimens which cannot be examined for internal features. The distribution of all species is extremely limited.

All the species known at the present time inhabit springs, spring-fed streams and caves. A special search is usually necessary in order to find them. Many apparently suitable waters have never been examined. Undoubtedly other species—perhaps many—are yet to be discovered or distinguished; the field appears to be scarcely more than scratched. A canvass of suitable territories and a monographic treatment of the subject is being pursued by Floyd E. Potter of San Antonio and Alvin Flury of Austin.

## THE MAP TURTLES OF TEXAS

HOBART M. SMITH, A. and M. College, College Station

Previous reports have indicated the occurrence of five kinds of map turtles in the state of Texas: **Graptemys geographica, G. oculifera, G. p. pseudogeographica, G. p. versa,** and **G. p. kohnii.**

Examination of material in the Strecker Collection at Baylor University, and of other material in the Texas Cooperative Wildlife Collections at A. and M. College, indicates that four of these forms are not known to occur in the state, and that the other is actually not a race of **G. pseudogeographica.** At the present time only three forms can be regarded as definitely known:**G. versa** and two unnamed races of **G. pseudogegraphica** related, one of **kohnii,** the other to **pseudogeographica.**

Records for **G. geographica** and **G. oculifera** were based apparently upon **G. versa,** which shows no kinship with **G. pseudogeographica** sufficient to warrant subspecific nomenclature. **G. p. kohnii** and **G. p. pseudogeographica** each are found to be composed of at least two distinct races, one of each of which is known to occur in the state. To neither of these two races are the subspecific names **kohnii** and **pseudogeographica** applicable.

## BLOOD OXYGEN SATURATIONS AND DURATION OF CONSCIOUSNESS IN ANOXIA AT HIGH ALTITUDES

CARL E. HOFFMAN, ROBERT T. CLARK, JR. and E. B. BROWN, JR.
School of Aviation Medicine, Pensacola, Florida

American Journal of Physiology 145 (5): 685-692, 1946.

Flight students and Hospital Corpsmen were taken individually to simulated altitudes of 28,000 ft. to 38,000 ft. in a low pressure chamber and had their masks removed. While at altitude, each subject performed a simple task of card sorting. Times to error, onset of convulsive-like movements, and mask replacement were noted and recorded. These activities were continued until unconsciousness was imminent at which time the mask was replaced and 100% oxygen administered. Blood oxygen saturations were estimated with a Millikan oximeter by conventional oximeter technique. Pressure altitudes were determined by a mercury manometer, and oxygen pressures in the chamber were recorded from a Pauling oxygen analyzer. This procedure was repeated for 25 subjects at each of 4 altitudes: 28,000, 30,000, 35,000, and 38,000 ft. Times to imminent unconsciousness were 141 sec. at 28,000 ft., 98 sec. at 30,0000 ft., 72 sec. at 35,000 ft., and 47 sec. at 38,000 ft. Average times of useful consciousness, as determined by the appearance of first error in card sorting, were 100 sec. at 28,000 ft., 73 sec. at 30,000 ft., 46 sec. at 35,000 ft., and 35 sec. at 38,000 ft. The period of useful consciousness was found to be approximately ¾ of the total time consciousness was retained. Blood oxygen saturations averaged 64% at the appearance of first error, and 56% at imminent unconsciousness with very little variation between altitudes and the appearance of any particular anoxic symptom.

## GENETIC RELATIONSHIP OF DOMESTIC AND WILD SPECIES OF SHEEP AND GOATS BASED ON HYBRIDIZATION AND ON COMPARATIVE SUSCEPTIBILITY TO DRUGS

B. L. WARWICK and R. O. BERRY
A. and M. College, College Station

Sheep and goats, both wild and domestic, have always been considered very closely related. There are very few morphological characteristics which can be assigned to one which may not be found in some forms of the other. However, taxonomists have long classified most of the sheep in the genus **Ovis** and most of the goats in the genus **Capra.** There are two additional genera usually called sheep, i.e., **Ammotragus** and **Pseudois,** and one other genus usually called goat, i.e., **Hemitragus.** The published accounts of attempted hybridization, natural hybridization and the results of experimental matings at this Station tend to confirm the main part of the classification. All species of **Ovis** are interfertile so far as recorded information shows. Also, all species of **Capra** which have been tried are interfertile. All inter-genera matings have resulted in either infertility or abortions. We have made many attempts to produce hybrids between the domestic sheep **(Ovis aries)** and the domestic goat **(Capra hircus).** When the male sheep was mated to female goats, half or more of the matings were fertile, but the embryos died and either resorption or abortion ensued before the middle of the gestation period. When the reciprocal cross was attempted there was no evidence of fertility. We checked part of the matings by autopsy of the females two days after mating and found non-cleaved eggs in the oviducts. When mating attempts were made between a male of **Ammotragus lervia** and domestic sheep none of the matings were fertile, while matings of the same males with domestic goats yielded some fertility including a full term still-born hybrid, but no live births. This would point toward the **Ammotragus lervia** as being more nearly kin to **Capra** than the common name, Barbary sheep, and the earlier classification with **Ovis** would indicate. Matings of **Hemitragus jemlahicus** males to domestic goats at this Station resulted in abortions. Attempts to mate the same males with female sheep were not successful. **Hemitragus,** commonly called Himalayan tahr, or tahr goat is probably correctly classified as a separate genus of goats.

It has been generally accepted that domestic goats are more susceptible to toxic effects of nicotine than are domestic sheep. Experience with our experimental animals indicates that nicotine sulphate combined with copper sulphate in dosage commonly used with domestic sheep is toxic to **Ammotragus lervia** but not to **Ovis musimon.** This reaction to nicotine would tend to support our suggestion that **Ammotragus** is more closely related to **Capra** than to **Ovis.**

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# GENETIC RELATIONSHIP OF DOMESTIC AND WILD SPECIES OF SHEEP AND GOATS BASED UPON COMPARATIVE CHROMOSOME COMPLEXES AND ON EMBRYO STUDIES

R. O. BERRY and B. L. WARWICK, A. and M. College, College Station

In considering the evolution and relationship of groups of animals it is plausible to consider the changes that may have occurred in the chromosome makeup of these various groups. Some of these changes may be expressed in visible alterations of the chromosomes while others are so minute that they go unnoticed. Since in mammals the occurrence of chromosomal aberrations is likely to produce non-functioning gametes, many such changes are not perpetuated. Therefore, the chromosome complex of a group of animals of the genus might be expected to show a similarity of chromosomes. In this laboratory, studies have been made of the following species of the sub-family **Caprinae:** domestic sheep **(Ovis aries)**, domestic goat **(Capra hircus)**, mouflon **(Ovis musimon)**, Bighorn **(Ovis canadensis Nelsonii)**, Aoudad or Barbary sheep **(Ammotragus lervia)**, and Himalayan Tahr **(Hemitragus jemlahicus).** Testicular material from each of the above species was fixed in acetic-alcohol and stained by the aceto-carine smear technique. The diploid chromosome number on each species of **Ovis** is 54. Each species also possesses three pair of large V-shaped chromosomes which appear to be characteristic of true sheep. One chromosome smaller than any of the others is also present in each group. Insofar as the morphology of the metaphase chromosomes are concerned they are similar in the three species.

The chromosome number of **Ammotragus lervia** is 58. One pair of large V-shaped chromosomes is present. These two chromosomes are similar to the V-s of the sheep.

In the domestic goat **(Capra hircus)** the chromosome diploid number is 60. These chromosomes are all rods or spherical in shape and none of them are in the form of large V-s as found in sheep.

The Himalayan tahr **(Hemitragus jemlahicus)** has 48 chromosomes. Some of these chromosomes are V-s but they are much smaller than those of the sheep. Because of the presence of the V-shaped chromosomes the tahr differs from the domestic goat in chromosome morphology as well as chromosome number.

The embroyos from crosses of the sheep X goats furnished the material for our studies of the chromosomes in the hybrids. The chromosome number from the somatic cells (amnion) of these hybrids is 57. This is the expected number since the sheep and goats each contribute 27 and 30 chromosomes respectively. Most of the chromosomes in the two species are indistinguishable when brought together in a single somatic cell, however, three of the six large V-shaped chromosomes which are characteristic of sheep are present in the hybrid.

In an attempt to gain evidence as to the uterine physiological relationship of sheep and goats we have made a series of embryo transfers between domestic sheep and goats. The embryos were obtained during early cleavage from the oviducts of animals that had been bred for 48 hours. The oviduct of the donor was irrigated and the fertilized egg was picked up with a hypodermic needle and injected into the lumen of the left horn of the uterus of the recipient.

Some of the sheep embryos developed in the goat foster mother and were alive and normal at 45 days of age but death and resorption usually occurred around 40 days in these transfers. In the reciprocal transfers in which 4 to 8-celled goat embryos were placed in the uteruses of sheep, all embryos were being resorbed at 30 days of age. Judging from the size of these embryos and their amnionic sacs they had not gone much beyond 20 days in their development.

In both cases development of the embryo as well as the embryonic membranes was initiated but the uterine physiology of the foster mother was not favorable for the complete development of the transferred embryos.

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## EVOLUTION OF THE OPHIDIAN HYOBRANCHIUM

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The hyobranchium of snakes is most frequently seen as a greatly reduced Y-shaped structure of thread- or cordlike proportions, the posterior arms of which have been regarded as ceratohyals or thryohyals, the basal portion as the basihyal.

Examination of this structure in 123 specimens representing 97 species and all families of snakes reveals a remarkable infra-family constancy, an important inter-family variation outlining 3 superfamilies, and apparent errors in hyobrancial nomenclature.

The most primitive condition occurs in the Anomalepidae, in which the hyobranchium is m-shaped. Extremely fine vestiges extend from each free end toward the angle of the jaw. The entire structure is therefore regarded as of hyoid arch origin. The lateral vestiges are properly considered ceratohyals. The median portion is the basihyal, and the remainder is most reasonably regarded as the hypohyal.

In the superfamily Boidoidea (Uropeltidae, Aniliidae, Xenopeltidae, Biidae) the hyoid is Y-shaped, with a very short or missing basihyal, and long, divergent, deeply-penetrating cornua which are interpreted as homologues of the anomalepid hypohyal. Accordingly the terms ceratohyal and thyrohyal are regarded inappropriate.

All remaining families except the Leptotyphlopidae and Typhlopidae comprising the superfamily Colubroidea (Colubridae, Elapidae, Hydrophiidae, Viperidae, Crotalidae) have a modified Y-shaped hyobranchium with better developed basihyal and juxtaposed cornua.

The hyobranchium of the Typhlopidae and Leptotyphlopidae are to be considered of independent derivation from anomalepid-like ancestors. In these families the hyobranchium is precisely Y-shaped, deep, with a long basibranchial subequal in length to the short, divergent cornua. Other evidence places all three families in the superfamily Typhlopoidea.

## THE EFFECT OF THE PLANT GROWTH HORMONE, 2, 4-DICHLOROPHENOXYACETIC ACID (2, 4-D), ON NUT GRASS AND SEVERAL OTHER WEED PESTS IN SOUTHERN UNITED STATES

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Two years ago Hamner and Tukey (2) published the first report of the herbicidal action of a growth-regulating substance or plant hormone called 2, 4-dichlorophenoxyacetic acid or 2, 4-D. Subsequently, numerous reports have been published on the results obtained from the 2, 4-D treatment of many different weeds in different parts of North America and in Europe. Marked progress has also been made with other types of herbicides besides 2, 4-D during the past decade (3). Willard (9, 10) has prepared excellent resumes on the status of 2, 4-D as an herbicide up to 1946. Much of the stimulus for the extensive herbicidal investigations now under way in the United States and Canada should be credited to the Western States Weed Control Conference (13 states). The time is ripe for similar organizations in other parts of the United States because weeds respect no boundaries and are, if anything, even more destructive in the southern states than in the North or West. The Proceedings of the Second Annual Meeting of the North Central States Weed Control Conference (1) summarizes the herbicidal work done on 2, 4-D in all 13 states and in Canada through 1945. Still more recently, the work of the U. S. Government during the war on new herbicidal and growth-regulating chemicals have been published in the Botanical Gazette (5, 6, 8, and others).

### Florida Experiments

The first experiment was conducted on lawn weeds in an attempt to control the worst pest, the so-called sand spur grass. All results were negative for this weed, but some of the others, like plantain, dandelion, and wandering jew, were readily controlled by one spray of 2, 4-D (1-1000). Some other broad-leaf weeds were also controlled, but because they were in the seedling stage their identity was not ascertained. None of the grasses, including St. Augustine grass, seemed to be adversely affected.

In 1945 work was initiated on the wandering jew weed (Tradescantia sp.) that was infesting a number of the gardens in northern Pinellas county. Spray experiments were started in early autumn before garden-planting time. One application of 2, 4-D (1-1000) gave excellent control. Some epinasty and distortion were showing within one week. This was followed by a progressive chlorosis which resulted in the death of the plants in about three weeks. One part of a sprayed garden was harrowed and planted at the end of two weeks, with the remainder receiving the same attention a week later. Practically 100 per cent control of this weed resulted. It bears repeating that the same spray treatment used previously killed patches of the same weed in lawns. No adverse effects from spraying with 2, 4-D were observed on the garden plants grown subsequently in the treated soil. One weed, an **Oxalis** species, showed chlorosis several days after treatment but later recovered.

It was noted in spraying lawns that nut grass was apparently killed. However, new growth appeared within a month of treatment necessitating further treatment. While inconclusive these results invited further study.

The most striking work done in Florida was on the water hyacinth **(Eichornia crassipes)** which was controlled by spraying with 2, 4-D (1-1000) as reported in Science (4).

## Texas Experiments

The Texas experiments were begun in September 1946, employing 2, 4-D (1-1000) for the control of nut grass **(Cyperus rotundus** L.) infesting the lawns and cultivated garden soils. Three or more six-foot-wide strips of lawn and garden, heavily infested with nut grass, were sprayed at 4-week intervals with alternate strips being left for checks. At the end of 4 weeks the alternate check strips were sprayed. Two weeks later, or 6 weeks after the first treatment, the original sprayed strips were resprayed. The same sequence was repeated for the alternate check strips. By early December the first series had been sprayed a total of three times and the second series twice. The results confirmed those obtained in Florida, that is, the sprayed nut grass was apparently killed, but new growth would appear from the soil about two or more weeks after the applications. By the time the second spray was made the new growth had become about 4 inches tall. Incidentally the second growth was much thinner.

It was repeatedly observed that the sprayed nut grass stopped growing almost immediately and then gradually became chlorotic. The foliage became necrotic at the tips within between 4 and 5 weeks after the spray applications. At about 4 weeks the tops were easily detached from the roots by grasping with the fingers. When carefully removed from the soil it was ascertained that a progressive necrosis had developed in the region joining the leaves with the roots and the adjacent corm or nut. The entire plant seemed affected, with necrosis least marked in the extermities. Attached to many of the plants were a string of nuts joined by relatively fine rhizomes. Based on the plants examined in this study, the 2, 4-D herbicide did not seem able to go beyond the first corm being formed at the base of the plant. It was repeatedly observed that the remote nuts sprouted and sent up new growth. This apparently was the source of the new growth mentioned earlier. Too little is known at this time to draw conclusions on the developmental story in the formation of the nuts, about how they grow and when they cease to grow and store food, and about when and how they produce sprouts for initiating the new growth. This study will be continued in 1947 in the expectation of finding out whether 2, 4-D is capable of completely eradicating nut grass. To date three applications seem to have given satisfactory control of all growth above ground.

Counts were made of the percentage of plants dying about 4 weeks after each application in several one-foot-square areas. Usually over 80 per cent of the tops were chlorotic and about dead at that time. Since most of the plants surviving were young in appearance, it was assumed that they arose from the nuts remote from the base of the sprayed plant. It was not convenient to mark the individual plant to be certain on this point. However, when sprayed plants were dug at weekly intervals after spray application, it was noted that sprouts were growing from some of the nuts remote from the plant base. This is good circumstantial evidence as to the origin of the new growth.

In connection with the lawn sprays it was observed repeatedly that no adverse effects were produced on the lawn grass which included Bermuda and other common species. One part of the lawn not included in these experiments had a heavy growth of bur clover **(Medicago hispida)**. One application of 2, 4-D spray gave a complete kill when the plants were about 3 inches tall. The same treatment also killed silverleaf nightshade **(Solanum eleagnifolium)**. The clover plants became chlorotic, wilted and died within about 2 weeks. Nightshade became chlorotic but it required over 4 weeks for death to occur. The most striking morphologic symptom on nightshade was the enlargement of the taproots. The root diameters of several of the sprayed plants measured more than twice normal size. Insects and secondary organisms invaded the affected roots so that at about five weeks after treatment nothing remained but the central core. When free-hand sections of these roots were examined about 3 weeks after treatment the enlargement seemed to be confined to the cortex and due to cell enlargement similar to that reported by Tukey, et. al. (9.)

A number of other broad-leaf lawn and garden weeds were killed, but because they were in the seedling stage at time of spray application, their true identity was not established.

The 2, 4-D spray (1-100) was also applied to a number of garden plants including sweet potato, watermelon, potato, and tomato. These plants were all killed eventually with the sweet potato and tomato being at first stimulated to abnormal growth, especially near the growing points. Some tomato plants were still living although badly distorted at the end of 10 weeks. A thick stand of small (6 to 8 inch) huisache (mesquite) tree seedlings were sprayed. This was followed within a week by extreme disortion, dwarfing and twisting of the younger ,newer growth, followed by death in about 8 weeks.

## Discussion and Conclusions

While these studies are far from conclusive, they clearly indicate the susceptibility of nut grass to the 2, 4-D spray especially in the autumn of the year. The large amount of work now being done in many states indicates the expanding role of 2, 4-D, the most important chemical herbicide ever introduced.

The mode of action of 2, 4-D herbicide seems to vary from one plant species to another. Because the action is slow, it would appear that hormone movement is from cell to cell rather than through the phloem translocation channel as seems to be the case for ammonium sulfamate and sodium chlorate.

It is significant that 2, 4-D is selective in its action and that it appears specific for some of the more noxious weeds ,bindweed, hyacinth, etc.). Although it appears incapable of inactivating the corms or nuts of nut grass remote from the base of a plant, there is a strong possibility that several successive eradication sprays applied to the foliage will control this weed. The possibility should also be explored of spraying the soil containing the nuts. The full answer will depend on the outcome of future work.

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## PRELIMINARY INVESTIGATION OF THE OXYGEN SOLUTION OF CHLOROPLASTS SUSPENDED IN QUINONE SOLUTIONS

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The oxygen evolved from spinach chloroplasts suspended in solutions of quinone was measured by the manometric method. Oxygen evolution was observed only upon illumination. A concentration of 0.0003 Molar quinone was found to release the most oxygen under the conditions employed. The quinone was made up fresh for each experiment and was buffered with McIlvaine buffer at pH 6.8.

Comparable concentrations of fresh chloroplasts were found to liberate more oxygen in quinone than in Hill solution. Stored chloroplasts which were partly inactivated liberated more oxygen with quinone than with Hill solution. The addition of small amounts of potassium chloride to the suspensions was found to favor greater oxygen evolution than when either Hill solution or quinone were used alone. Potassium chloride was also found to activate oxygen production from the washed sludge obtained from the centrifugation of chloroplasts ruptured by supersonic vibration. This activated material evolved some oxygen, whereas without potassium chloride, no oxygen was evolved either with quinone or with Hill solution .

## THE ILLS OF TAXONOMY

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Biologists often spreak of their taxonomic brethren much as the opposite sexes are given to speaking of the other, disparagingly, but with realization of their ultimate dependency. Occasionally some critic reaches the end point and publishes his criticisms. Seldon does a taxonomist raise his head from his complicated little world and bother to reply. Apparently no taxonomist cares what anyone says about him, if the critic is not another taxonomist.

Recently Ball (**Science** 103: 713-714) raised several issues under the caption, "Why is taxonomy ill-supported?" His title might have more appropriately been, "Why taxonomy is difficult." He contends that rewards are bestowed in taxonomy for creating names, not for knowledge of the organisms named, and that no stigma is attached to creating hosts of synonyms. He overlooks the fact that the total knowledge about most organic species is the original, taxonomic description and whatever additional facts are given with it. Biologists interested in the general natural history of a species know from experience that a great deal of such information is published in taxonomic papers. As a matter of fact, taxonomists are probably better acquainted with the general biology of the groups of organisms with which they work than any other class of biological workers. The charge of overspecialization and ignorance, which Ball (**op. cit.**) made, is true in some specific instances, but in general it is no more true of taxonomists as a whole than of other specialists of the biological fraternity. Not long ago I heard a well known biologist say, "People who know the Animal Kingdom belong to a past generation and are dying out." After hearing a recent graduate Ph. D. in zoology (not taxonomy) ask what a ctenophore was, I am inclined to agree with that statement.

Ball's statement that no stigma is attached to creating vast numbers of synonyms and that recognition is based on the number of names a taxonomist creates, must be qualified. Taxonomists receive the approval or opprobium of their colleagues and successors in the same way that all other scientific workers do, namely, by doing a good job. Any worker in taxonomy soon comes to know who is dependable and who is not.

Ball's statements are largely indictments of the rules under which taxonomists work. It is quite true that they are defective in that more and more time is required to interpret them and to exercise care in following them, resulting in less time devoted to acquisition of purely biological knowledge. In moments of dissatisfaction with this state of affairs, I have sometimes declared that one should study law rather than biology, before going into taxonomy. That is an exaggeration, but it emphasizes the problem. On the other hand, taxonomic rules of procedure are like many accepted rules of human behavior. They are tedious, inhibitory and fail to give justice in many cases. Nevertheless, they are the best that have been brought forward to date and without them all is chaos. Hence they must be observed until a better set of rules is made. Many things have been learned since the rules were set up, which could be applied to improving them. I do not class myself as a taxonomist, but I can see a few things that would help. A minor issue (I know of only two instances) is that an arrant crackpot can designate a species by a new Latin name and, because he happens, probably by chance, to follow the rules of taxonomy concerning publication, his names are accepted into the literature as synonyms. Probably a rule defining questionable avenues of publication would take care of the issue.

In discussing why taxonomy is ill-supported, it should be remembered that the field was abandoned long before the work was completed. Not for a great many years has the majority of leading biologists been systematists. Competition for funds and lack of great leadership has partly caused the decline of taxonomy. Nevertheless, the ultimate value of systematics to the study of experimental evolution, plant and animal breeding, ecology, oceanography, and numerous other fields is as important as ever, and there seems to have been a recent resurgence of interest in the subject among biologists in other fields. But systematics has declined to the extent that there are no students or specialists in certain groups and it is, therefore, a virtual impossibility to get species of numerous groups of animals identified with any degree of certainty. When continuity in a field is broken, progress not only stops, but the amount of available knowledge actually declines or is temporarily unavailable until at some later date someone else with waste of time and energy, takes up the matter and learns it over again. Thus it is with the taxonomy many groups of animals.

Taxonomy requires as much wisdom and intelligence as any other field of biology, and in no other field are the results obtained more closely correlated with the amount of work expended. Progress in taxonomy is slow and steady, and is usually without the brilliant, important discoveries that sometimes come quickly in other fields. Yet the rewards in advancement and standing as a biologist are not commensurate with what may be obtained in other fields of research. This causes most younger workers to shy away from the field. This is unfortunate, for biological science would prosper better if the systematic field were more actively cultivated. Under the **status quo,** only those who are willing to make greater than usual sacrifices, the effects of which will be felt over a whole career, and who are sustained by an unquenchable interest in the subject, can expect to make a success in taxonomic research.

Taxonomists as a whole lead frustrated lives, not only because they are starved for funds, but because available collections of specimens are usually far from complete and taxonomists continually wish for more. The custom of carrying author's names after species described by them should be kept, not abolished as suggested by Ball (**op. cit.**). It boosts the systematist's morale and has another value. No other field of science is so necessarily historically minded. To illustrate specifically, if I run across the name of a fish, with which I am totally unacquainted, followed by Meek and Hildebrand, I know that the species comes from Panama and that a description will be found in "The Fishes of Panama" by Meek and Hildebrand. Therefore, I do not waste time looking for a description in Gunther's "Catalogue of the Acanthopterygian Fishes in the Collection of the British Museum," Regan's "Pisces Centrali-Americana," or Linnaeus "Systema Naturae," 1758. Multiply this untold thousands of times and some idea may be gained of the value of author's names to systematists. Author's names are brief, clear indicators or pointers, which all taxonomists learn to use quickly to shorten and facilitate their labors. Without them the bibliographic work would be much more difficult than it is, and it is difficult enough under the present system. For the same reason the custom of using parentheses around the author's name, after a species has been revised, should be retained.

The field of taxonomy should perform a service to all other biological sciences. For that reason taxonomists should spend more time remarking ranges and preparing adequate keys of the various animals and plants, which other biologists can use. The establishment of closer cooperation with, and more sympathetic understanding of, taxonomists' problems by other biologists would be facilitated by greater attention of taxonomists to the service side of their subject. Taxonomists do spend a great deal of time corresponding with and identifying a few specimens here and there for other biologists. This service, however, is haphazard, inefficient and time-wasting. A great deal of such labor could be avoided if good keys and range maps were available to the general biologist. Furthermore, such works would lead to increased use of systematics by the general biologist. Today many problems are avoided or given shallower treatment than they deserve because of the difficulties of getting specimens identified. In addition some sad cases of publication of false information would be avoided if good keys were available. These instances sometimes happen because biologists are ignorant of taxonomy or, even if they know better, are forced to do the best they can with the publications available. Indeed the much lamented low estate of taxonomy is doubtless due in part to the fact that taxonomy has failed largely to perform the service for the other biological sciences that is necessarily expected of it.

Naturally, taxonomy has become more and more refined, and smaller and smaller differences can be detected in these days of vernier calipers, slide rules and statistical formulae. Although in some ways it may add to our knowledge of variations in animals and plants, there is some question in my mind that the superfine study of varieties and races and the piling up of examples is of much value. It keeps the systematists hand in, so to speak, but it is so well known that adequate samples of most species, having a wide geographical range, will show detectable variations, that there seems to be little reason to ferret out the differences unless some particular problem or question is held in mind. An intensive population study program, with a particular purpose in mind, such as is sometimes carried out in fisheries biology, will detect and utilize such differences and derive valuable information from them. Otherwise their value is not so clear.

The present system of zoological nomenclature uses Linnaeus' "Systema Naturae," Eleventh Ed., 1758 as the starting point. Not even the general outlines of the relationships of most plant and animal groups were known in those days. Naturally, there has been a great deal of change in terminology as better knowledge was gained. Long lists of synonyms have been worked up, although everyone realizes it is quite impossible in many instances that they are more than approximately correct. To some extent, long lists of synonyms are reflections of increased knowledge, as well as indications of the primitive views of early workers and the foibles of taxonomists in general. These long lists of synonyms should be of no concern to the general biologist. He may as well take the last name given, without quibbling. If he must search the older literature for some points, then the synonymic list may be used as a guide. In other words, lists of synonyms are none of the general biologist's business and they concern matters he does not usually understand, nor which would yield him any biological information.

The last point is important to the systematist. He spends a great deal of time working on matters which yield no biological information. Why then can not taxonomists set up more recent milestones than Linnaeus' "Systema Naturae" Eleventh edition 1758, for the various groups and have them accepted, as the major delineations of the major plant and animal groups are worked off? They would have to be different for the different groups. The time will come for them all and taxonomists will be forced to this expediency at some future date, unless they wish to become more and more historians with merely a certain biological slant, adding little actual knowledge to the field of biology.

### Summary

Taxonomy is ill-supported and unworked, although other branches of biology are fundamentally dependent upon it. Taxonomists should give better service to other biologists through adequate keys and range maps. Taxonomic rules need revision. Most criticisms of taxonomists are actually indictments of the rules. More recent starting points than Linnaeus' "Systema Natarae," Eleventh Ed., 1758, should be set up for the various groups of plants and animals.

## LEGUMINOSAE OF EAST TEXAS

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This taxonomic-ecological study deals with native and naturalized legumes of a portion of East Texas. The area studied includes a part or all of fifteen East Texas counties, which may be bounded by drawing a line beginning at Palestine and proceeding southward through Midway to Montgomery, thence eastward to Conroe, through Cleveland to Buna, then northward through Jasper, San Augustine and Center to Teneha, thence westward through Timpson, Rusk and back to Palestine.

Within this area are found, broadly applied, four vegetational types which may be indicated briefly, as follows:

I. Pine Woodlands: This type occupies a major portion of the area under discussion. The term will have to be broadly applied, as various localized associations occur which deviate somewhat from the two principal climaxes. This type woodland forest occurs on light colored, sandy soils, with yellow and reddish friable sub-soils. The principal soil series on which this type occurs are Susquehanna, Ruston, Norfolk and Segno.

One of these climaxes, the loblolly-hardwood forest type, characterized by a luxuriant growth of loblolly pine, tall hardwoods and evergreen shrubs, dominates the more fertile and better watered phases of this soils group. These soil types are fine sandy loams known locally as hammock lands and are circumneutral in their reaction. This mesophytic forest climax is typical of the "Big Thicket" of East Texas and extends into the eastern part of Montgomery, San Jacinto, Polk, Tyler and Hardin Counties.

The other climax, the shortleaf-loblolly forest type, dominates the less fertile, drier phases of the pine woodlands soil group. The pines are accompanied by scattered red oaks and post oaks, black and white hickories, and poor quality sweet and black gums. Throughout parts of Anderson, Houston, Cherokee and Nacogdoches Counties, in areas where deep sands are common, sandjack and blackjack, in association with shortleaf pine predominate. These soils are more xerophytic, as are the red, hilly soils that occur alternately through this region. The red hill soils, whose clay sub-soils are rich in ferruginous compounds, are usually high in acidity. Shortleaf pine, in association with hardwoods, occurs abundantly in such situations. The shortleaf-loblolly type, alternating with shortleaf-scrub hardwood types, may be said to occur erratically northward from the town of Montgomery to Palestine, eastward through northern Houston, Cherokee and Nacogdoches Counties. These type associations border the westernmost extension of the East Texas Pine forest belt.

II. Post Oak Woodlands: This vegetational type includes a post oak-blackjack oak association or scrub hardwood forest in the area studied. This type occurs on tight, silty clay transitional soils (Lufkin series) between true prairies and true woodlands. A longleaf pine forest type accompanied by scrub hardwoods extend east and west across a part of Trinity, Polk, Angelina, San Augustine and Shelby. This belt of longleaf pine-scrub hardwoods is not to be confused with the longleaf pines occuring in more nearly pure sands eastward into the coastal flat lands.

III. Blackland Prairies: Prairie vegetation is characteristic of the Lagarto clays and smaller areas throughout the Catahoula and Jackson formations. The black to dark grey, heavy clays belong to the Houston and Wilson series, both surface and subsoil of the Houston black clay are calcareous. The Wilson clay loam is a blackish grey soil possessing free carbonate in the sub-soil but not in the surface soil. Small prairies of Houston occur as "island outcrops" eastward into the piney woods section of San Jacinto, Polk, Angelina, and other East Texas counties. These small prairies are surrounded by pine forests, and it is interesting to note that the forests show only a few yards of invasion in a period of many centuries. Significantly, typical southwestern flora (prairie) occur on these small outcrops, whereas if removed only a few yards into the sandy pine soils, they would not survive.

IV. Bottomland Hardwoods: This vegetation represents two types, the elm-oak hardwoods on the clay soils of the larger stream valleys which are usually referable to the Trinity or Bibb

> series, and the loblolly pine-hardwoods of the sandy smaller stream valleys which belong to the Ochlockonee soil series. The Trinity River bottoms are characteristic of the first named forest type, and the Neches River bottoms are characteristic of the second named type.

It is to be noted that the area under discussion presents unusual conditions or situations. Transition zones, xerophytic prairie situations, mesophytic "Big Thicket" area, leached sand hills, eroded calcareous outcroppings in the pine forests, and various soil and topographical differences make for a varied plant array difficult to correlate and explain, but interesting to study. There is a question of the advisability of including within this study an area so varied, but since this is an ecologic as well as a taxonomic study, perhaps the inclusion lends emphasis as well as interest. It is remarkable that certain species of legumes lend themselves to naturalization along the western part of the area studied, whereas farther eastward they are grown with difficulty. Another point in favor of heterogenous inclusion is that a situation is created whereby soil tolerances and non-tolerances of certain native species are brought to the attention of the student. This also has a practical value for the agriculturist as well. To attempt to grow certain legumes in the "pine soils" of East Texas that are adapted to the heavier soils would be highly impractical. It should be mentioned that many species of legumes which do not occur on either alkaline or acid soils may occur on neutral or transitional soils composed of alkaline and acid soils.

That remarkable plant variations occur throughout East Texas, no ecologist who has observed the flora would deny. It is significant how closely certain plant formations follow certain types of soils in the region. This is strikingly expressed in the formation of prairie, post oak ridges and pine lands. According to Warner (1926) certain physical and chemical influences may effect the plant array. The following is taken from this source:

"The plant structure in itself is an important factor in determining plant distribution. Heavy clays and chalky soils influence the development of root hairs. The greatest influence of soil texture is indirectly related to aeration, water capacity and water movement. This is indicated by the decided difference in valence of frequency of each species with changes in soil texture; by the occurrence of a number of species in dry, well aerated sands that are infrequent in dry, poorly aerated leached clays; by the presence of a number of silicicoles common to alkaline and leached sands and infrequent upon clay soils; by the difficulty of root development in the sub-soil of prairies of this area; and by the intolerance of certain plants to destruction of lateral roots by soil cracking. Much of the difference in the structure of the vegetation of the respective soil types of this area is due to soil texture and aeration."

"Water apparently is not the major controlling factor in determining the difference in the structure of edaphic formations under consideration, although it is an important factor in the xerophytic, semi-xerophytic, mesophytic, and hydrophytic divisions of edaphic formations. Evidence that water may be of a minor importance is shown by the society of winter annuals and weeds on cultivated soils which are little affected by the water differences."

"The maturity of the soil as indicated by its chemical nature is a very important factor in plant distribution. Apparently it is the major one in determining the edaphic formations of this climatic region as shown by characteristic weed societies for cultivated soils of unlike chemical nature; yet similar in being well aerated and supplied with moisture, occurrence of distinct winter annual societies on leached and unleached soils; the presence of species common to alluvial and upland unleached soils, but infrequent or absent on upland leached soils; the difference in the association on calcereous and leached sand; the lack of similarity in the hydromeophytic associations of acid swamps and alkaline swamps, and the qualitative and quantitative differences in microorganisms of soils of contrasting chemical characteristics."

Although this brief discussion of ecological factors pertaining to the problem at hand is incomplete and inclusive, it may include some of the more significant factors operating to bring about the floral array in this area.

Although considerable areas throughout East Texas have at one time or other been in cultivation, especially in prairie soils and more level sandy soils, there remains some few tracts of land that have been relatively little disturbed other than one or two cuttings of the pine timber. Where these tracts are fenced against hogs and cattle, and the natural balance has been little upset, the legumes and other plants occupy a position closely paralleling that of the past in their respective habitats. These situations are highly desirable in a study of this kind.

Space will not permit a detailed discussion of legumes in various successions, but remarks will be made where significance demands.

The Leguminosae constitute a conspicuous part of the flora of East Texas, exceeded only by the Gramineae, Compositae and Cyperaceae. One-hundred and thirty-eight species in thirty-eight genera are listed as occurring natively in the area studied, while seventeen species in ten genera are listed as naturalized or becoming established.

A study of the distribution patterns indicate that the most abundantly occurring single species is **Lespedeza striata,** common lespedeza. This is an introduced annual which has quickly and vigorously established itself throughout the sandy soils of this region. The specific representation of this genus ranks third, however. The genus **Meibomia** with seventeen species listed, occupies first place. Sixteen of these are sandy and transition soils. **Meibomia obtusa** and **Meibomia sessilifolia** are the two most abaundantly occuring native legumes in East Texas. The genera **Psoralea, Astragalus, Baptisia, Petalostemum** and **Vicia** are more or less abundantly represented in this legume flora of this area.

Certain species of **Petalostemum** and **Astragalus** rather strikingly segregate themselves as regards the soil on which they are found growing; some occurring on calcareous soils and others on sandy soils, or transitions of the two.

Collections were begun in February and suspended in December, 1946. Although sporadic collections have been made through several years, the most intensive work was done during the 1946 season. All legumes were checked at the S. M. Tracy Herbarium at Texas A. & M. College, College Station, and the S. R. Warner Herbarium located at Sam Houston State Teachers College, Huntsville, Texas. Some doubtfuls were checked at the University of Texas Herbarium. The sequence follows that used by Small.

## Native and Naturalized Legumes of East Texas

### Subfamily I. Mimosoideae

1. Acacia Tourn Mill.

**A. angustissima** var. **hirta** (Mill.) Kuntze. Prairie Acacia

A small tree or shrub, occurring on dry prairies, heavy soil near Willis, Montgomery County, Texas. Rarely occurring eastward. Not abundant. Spring and early summer. Fruit eaten by livestock. (**A. hirta** Nutt. **A. filicoides** Trel.)

**A. farnesiana** (L) Willd. Huisache or Sweet Acacia

A small tree occurring in thickets or clumps, several frequently branching from crown. Prairie soils, calcareous to neutral. Rarely occurring eastward. Walker and Montgomery Counties. Spring and summer. Valuable as a honey plant and wildlife food. Many uses commercially.

2. Desmanthus Willd. (Acuan Medic.)

**D. illinoiensis** (Michx.) Kuntze. Illinois Desmanthus

Perennial. Relatively abundant on prairie soils, especially alluvial deposits along roadsides. Quite variable in size, depending upon soil fertility. Not found growing in the pine soils of eastern area. Spring and early summer.

**D. leptoloba** (T. & G.) Kuntze. Prairie Desmanthus

Perennial. Ordinarily occurring in the southwestern part of the state. Specimens collected in deep sand near Augusta, Houston County, Texas. Flowering abundantly, but setting few seeds or fruit. Spring and summer.

**D. depressa** (Willd.) Kuntze

Perennial. Reported to be in this area of East Texas by Cory and Parks (2). A prostrate form.

3. Schrankia Willd. (Morcngia Britton.) Sensitive Briar

**S. uncinata** (Willd.) Britton.

Occurring frequently on red clay soils, dry situations. Perennial. Ordinarily separated from **S. angustata** on leaf venation. Larger and shorter pods seems to be a fairly reliable character to differentiate from closely related species. Early Spring and summer. (**S. nuttalli** DC).

**S. angustata** (T & G.) Britton

Perennial. Occurring in similar situations as the above and closely related. Abundant throughout sandy soils of East Texas. Regarded as good quail food. Early spring and summer.

4. Mimosa L.

**M. strigillosa** T. & G. Prairie Mimosa

Perennial. Localized throughout East Texas on prairie outcroppings. Markedly adapted to calcareous soils. Graded roadside banks, etc. Polk County, Texas. Spring and summer. Probbaly eaten by wildlife, good erosion control plant.

5. Neptunia Lour.

**N. lutea** (Leavenw.) Benth. Yellow sensitive briar.

Perennial. Occurring on prairies and open ground, neutral to calcareous soils. Lower Houston County, Walker County. Scattered throughout East Texas, but not in abundance. Spring and summer. Recommended as a soil binder and of value as quail food.

6. Prosopis L. Mesquite

**P. chilensis** (Molina.) Stuntz. Mesquite

A tree usually of small size, occurring singly or in clumps. Occuring on prairies of Houston, Walker and Montgomery Counties. Rare east of Crockett, Willis or Huntsville. A very valuable tree for wildlife, commercial uses and livestock food (beans). Spring to late summer. (**P. glandulosa** Torr. **P. juliflora** SW. DC.)

Sub-family II. Caesaepiniodeae

7. Cercis L. Redbud

**C. canadensis** L. Redbud

Native to East Texas on practically all soils. Early spring flowering. Small tree throughout the forest. Leaves appearing usually later than flowering. Undergrowth in pine-hardwood associations. Quail food. Squirrels reported feeding on buds and possibly the seeds. A very beautiful as well as valuable tree.

8. Cassia Tourn. Senna

The cassias proper are of little value in any situation, contributing nothing toward soil building or wildlife food. Species of Chamaecrista treated here under Cassia are quite valuable. This genus occurs quite abundantly throughout East Texas.

**C. medsgeri** Shafer

Perennial. Occurring throughout East Texas, found principally in alluvial soils. Along roadsides, open places. Recorded to be sparingly consumed by quail. Considerable controversy has arisen regarding the taxonomic position of this plant as associated with **C. marilandica.** Some authors use the names synonymous, others as a variety. According to M. L. Fernald (5) the plant Linnaeus called **C. marilandica** was hairy, so when J. A. Shafer found a smooth plant in western Pennsylvania, he named it **C. medesgeri.** However Fernald recently discovered that the specimen to which Linnaeus had given the name **C. marilindica** was really smooth, and therefore actually the same as **C. medesgeri.** Fernald therefore considers the latter name synonymous with **C. marilandica** and has proposed the name **C. hebecarpa** for the hairy plant known as **C. marilandica.**

**C. occidentalis** L. Coffee Senna

Perennial. Abundant around old house places, lots and gardens. Throughout East Texas prefers rich, sandy loams. Fruits in summer. Probably a weed in any situation having little or no wildlife value, the only record is of seeds found in the stomach of a Florida duck.

**C. tora** L. Sickle Senna

Annual. A weed occurring around gardens, fields and roadsides. Seeds in quantities found to be poisonous to bob-white. As this group bears no nodules on the roots they are practically worthless and possibly soil robbers. Summer.

**C. fasciculata** (Michx.) Greene. Partridge Pea

Annual. An excellent wildlife plant, soil builder (as it is a nodule bearer) and fair soil binder (when it occurs very thick in stands.) Honey is obtained from the nectaries at the base of the petiole. The quantity is sometimes criticized. (**Chaemaecrista fasciculata** of authors.)

**C. robusta** Pollard. Large Partridge Pea

Similar to the above but much more robust and taller. Found farther eastward with **C. fasciculata.** Less abundant, similar or same uses or value. Regarded by some authors as a variety of **C. fasciculata.** Summer. (**Chaemaecrista robusta** of authors.)

**C. nictitans** L. Sensitive Partridge Pea, Litle Partridge Pea

Annual. Occurring more localized throughout Eastern Texas. Alluvial soils in old fields; moist fertile situations. Excellent shade and cover for quail. Much later blooming and fruiting than **C. robusta.** (**Chamaecrista nictitans** of authors.)

**C. mississippiensis** Pollard

Reported by Cory and Parks (2) to be in this area. Probably in extreme Eastern part of area studied. (**Chamaecrista mississippiensis**)

### 9. Gleditsia L. Honey Locust

**G. triacanthos** L. Honey Locust

A tree occurring throughout Eastern Texas. Usually low growing and thorny. Found singly and in clumps. Source of honey during the short flowering period. Pods are high in sugar content and livestock relish them. Wood is durable if dried. Considerable value as wildlife food. Preferred habitat is rich woods and moist sites. However found on dry hills along gullies occasionally. Late spring and summer.

**G. aquatica** Marsh Water Locust

Scattered throughout Eastern Texas, becoming more abundant eastward. Swampy places, river bottoms. Similar uses as **G. triacanthos** but usually a smaller tree. Spring and summer.

10. Parkinsonia L.

**P. aculeata** L. Retama.Jerusalem Thorn

Shrub to small tree, found occasionally along the westernmost boundary of area studied. Montgomery and Walker Counties. Considered of value as a honey plant; no record of wildlife use. Spring to fall.

Sub-family III. **Papilionoideae**

II. Sophora L.

**S. affinis** T. & G. Necklace Tree

A small tree occurring scattered along the westernmost boundary of area studied. Occurring along streams depositing calcareous or neutral soils along their courses. Rare in Eastern Texas. Source of honey, but of questionable value to wildlife. Spring to fall.

12. Baptisia Vent.

**B. nuttalliana** Small. False Indigo

Perennials. Abundant throughout East Texas, open woods, old fields, roadsides, etc. Sandy, gravelly fertile soil. Very early spring. Of little value as wildlife food, non-nodule bearing.

**B. sphaerocarpa** Nutt.

Dry, gravelly soil. Less abundant than above species; railroad right-of-way. Angelina County. Late spring and early summer.

**B. leucantha** T. & G. White False Indigo

Along river banks, alluvial soil and fertile woods. More abundant toward the southeastern boundary of area studied. Spring.

**B. bushii** Small

Reported in this area by Cory and Parks (2). Not collected by writer.

**B. laevicaulis** (A. Gray) Small

Open woods and open old fields. Western part of area studied. Spring.

**B. lecophaea** Nutt.

Throughout East Texas, open woods. Spring.

**B.vespertina** Small.

Reported in this area of East Texas by Cory and Parks (2).

**B. australis** (L) Britton
var. minor. (Lehm.) Fernald.

Reported here by Cory and Parks (2), not collected by writer.

13. Crotalaria L. Rattle Box

**C. sagittalis** L. Winged Crotalaria

Annual to biennial. A very variable low growing native annual, or sometimes biennial. Blooms and fruits from early spring to late fall. Deep sand hills, woods and various habitats. Over all E. Texas. Of little value to wildlife. Reported to be poisonous to horses, and other livestock.

**C. spectabilis**

Introduced. This species is able to reproduce itself and should be regarded as naturalized in parts of the area studied. Regarded as an excellent soil builder both because of an abundance of nodules are produced and the foliage supplies organic matter upon decaying. It is of no value as a grazing plant. Late summer.

### 14. Lupinus (Tourn.) L. Lupines

**L. subcarnosus** Hook. Bluebonnet—Sandyland Bluebonnet (naturalized). Annual.

This plant is known as the sandyland bluebonnet and does not occur naturally on the blackland prairies, nor is it found eastward in the pineland soils. Occurs natively around Beeville, etc. Designated by legal error as the official state flower. Escaped locally around Huntsville and other E. Texas communities. Spring flowering.

**L. texensis** Hook. Texas Bluebonnet

Annual. A large and showy species. Very abundant on certain prairies, but extremely rare eastward. Probably quite beneficial to soil, since it is nodule bearing. Spring.

**L. perennis** L. (var. roseus Britton.) Pink Bluebonnet.

Perennial. Reported by Cory and Parks (2) to occur in the Southeastern part of the area studied. Probably more adapted to neutral and pine soils than the two species recorded above.

### 15. Medicago (Tourn.) L. Medic and Bur Clover

**M. lupulina** L. Black Medic

Naturalized in Houston, Walker and Montgomery Counties but could hardly be regarded as occurring naturally over a wide area eastward. In yard and fertile places occasionally around communities and towns, and along railroads where accidental seeding occurs. Collected in Diboll, Texas along Southern Pacific R. R. Valuable on eroded Houston and Wilson soils as pasture legumes. Spring. (Introduced).

**M. arabica** Huds. Spotted Bur Clover

Occurring as an escape in pastures around Huntsville, Texas. Apparently making little gain in establishing itself. Where abundant enough, excellent soil builder and temporary pasture. Spring. Naturalized. (Introduced).

**M. hispida** Gaertn. Bur Clover

Annual. Similar habitat as **M. lupulina,** but occurring more abundantly in yards, lawns and house places farther eastward. Adapted to calcareous or neutral soils and fertile situations. The value of this and the above are well known as soil builders, wildlife food and pasture plants. At least two varieties are recognized. Spring and later winter, also fall. (Introduced).

**M. sativum** L. Alfalfa

Apparently establishing itself on moist, fertile, calcareous soils where protected from grazing. Late spring and summer. Naturalized. (Introduced).

### 16. Melilotus (Tourn.) L. Sweet Clover

**M. alba** Desv. White Sweet Clover

Occurring naturalized in Walker and Montgomery Counties near the westernmost area studied. Fertile and alluvial soils, calcareous. A good source of honey and undoubtedly a good soil builder as well as binder in gullied blacklands. Observed growing several feet tall in alluvial deposits in gullies near Huntsville, Texas. Rabbits fond of this legume, especially during seasons when other forage is scarce. Biennial. Introduced.

### 17. Trifolium Tourn. L. True Clovers

**T. amphianthum** T. & G. Pink Clover

A low growing, pink blooming perennial clover occurring in various soils of a moist, tight nature where fertile. Abundant along roadsides near E. Texas streams. Good pasture plant, being somewhat shorter and smaller than White Dutch clover, **(T. repens)**, but similar in habitat and habits. Bears fertile seeds underground; excellent honey plant and very valuable wildlife source of food. Excellent soil builder and binder. Found in situations with carpet grass, **(Axonopus compressus)**, but tends to crowd this out slowly under ideal conditions. Spring to summer. Blooms in the fall if rainfall is sufficient.

**T. reflexus** L. Buffalo Clover

Annual. A large, bunch type clover occurring in retired fields in moist areas. Conspicuous flowers but probably of little value as a pasture plant. It is undoubtedly a good source of wildlife food where abundant enough. Angelina and Nacogdoches Counties, near Garrison, Texas. Spring.

**T. carolinianum** Michx. Carolina Clover

Annual. Throughout E. Texas on sandy and neutral soils, open places and along railroads, etc. The value of this plant is under-estimated as it furnishes considerable very early grazing, however, short; visited by bees; good nodule bearer. Dies late in spring and in most situations replaced by common lespedeza, a later spring legume. Frequently Carolina clover germinates in the fall and remains green throughout the winter in eastern Texas.

**T. bejariense** Moric.

Annual. This clover is not abundant in East Texas. Occurring during spring in cut over area of the piney woods. Similar to **T. carolinianum** but taller and with larger globuse heads. Not abundant enough to be of much value. North of Wynne Farm in Walker County in pine woods.

native to the area. This genus, like the above, occurs mostly on the

**T. repens** L. White Dutch Clover

Perennial. Occurring in moist rich soils throughout East Texas, becoming more abundant farther eastward. Will gradually disappear under carpet grass competition in Angelina County. This is probably because carpet grass grows rapidly on water soaked leached soils of this area. However, the process is modified somewhat westward. Fertility has a good deal to do with this also, especially phosphorus. The value of this clover is well known. An excellent honey plant, soil builder and pasture plant. Fall, spring and early summer. Introduced.

**T. dubium** Sibth. Sucklin Clover or Little Hop Clover

Perennial. This clover seems to be quite well naturalized in this area. Similar uses as White Dutch, but much smaller with yellow blossoms. Better adapted to drier and less fertile soils. Spring to early summer. Introduced.

**T. procumbens** L. Procumbent hop clover

A somewhat larger species than the above with beautiful flowering globose heads. This legume apparently becoming established sparsely where protected from grazing. Valuable in a pasture mixture and as a honey plant. Late spring. Introduced.

18. Lotus L.

**L. americanus** Nutt. Lotus

This legume is reported by Cory and Parks and others as occurring in this area of East Texas. Probably rare.

19. Indigofera L. Indigo Plant

**I. suffruticosa** Mill

Perennial. Occurring in thickets or bunches on sandy soils. Scattered throughout East Texas, frequently in deep sand in old fields. Probably has some value as a soil builder. Its ability to enrichen soil is questionable as no nodules are observed occurring on the roots. Probably of little value as wildlife food, but should afford some protection where growing abundantly. Summer. Houston and Nacogdoches County, etc. (**Indigofera anil** L.; **I. lindheimeriana** Scheele.)

**I. miniata** Ort.

Perennial. Occurring in both deep sand and prairie situations. Much earlier on prairies, later fruiting on sand; somewhat larger and more abundant foliage on deep sand. Huntsville and Augusta, .Houston County, (**Indigofera leptosepala** Nutt.) Spring

20. Tephrosia Pers. Devils Shoe String (Cracca L.)

**T. virginiana** (L) Pers

Perennial. Abundantly occurring throughout East Texas in sandy soils, especially in open scrub hardwoods and pine forests. Most abundant occurrence south of Jasper in gravelly sandy soil. Value as rotenone producer. Fruits observed to be eaten by bob white. Summer. (**Cracca virginia** L.)

**T. onobrychoides** Nutt.

Perennial. Occurring in less abundance than the above and in different situations, generally. Found in more moist soil and somewhat different forest associations. In Polk County the most abundant occurrence was in longleaf-loblolly or loblolly-longleaf associations. A much larger, more branching species than **T. virginica.** Summer.

**T. lindheimmeria** A. Gray

Perennial. Several specimens believed to be this species were collected in sandy soils of Walker County. Cory and Parks also report it occurring in this area. Evidently quite rare in East Texas. Summer.

**T. spicata** Walt

Perennial. Reported by Cory and Parks (2) to occur in East Texas. No specimen collected by writer. Probably extends into the eastern part of area studied.

**T. texana** (Rydb.)

Reported by Cory and Parks (2) to occur as far eastward as westernmost extension of area studied.

21. Wisteria Nutt (Kraunkia Small.)

**W. frutescens** (L) Poir

Occurring very abundantly in Neches River bottoms near Diboll, Texas. Rich bottoms in association with **Dioclea multiflorum.** Water and Willow oak association, open places. Abundantly fruiting late summer. Spring, summer.

**W. macrostachya** Nutt.

Not nearly so abundant as the above mentioned species. Found growing on station in Houston County near Kennard in creek bottom. Blooming throughout summer depending upon moisture available. Setting few seeds. Grown as an ornamental. Leaves much more rhombic than **W. frutescens.**

22. Robinia L.

**R. pseudo-acacia** L.

A small tree occurring as a native in northeastern United States and sometimes escaping in this area. Valuable as a honey plant while in bloom and planted as an erosion control plant and soil building in gullied areas. Excellent post timber. Spring and summer. Naturalized.

23. Sesbania Scop.

The .four species below are all treated as Sesbania, however the latter three are in literature, frequently treated as Glottidium and Daubontonia. They are of little or no value from an agricultural or wildlife standpoint.

**S. exaltata** (Rob.) Cory Colorado River Hemp

Occurring throughout East Texas in more fertile alluvial situations, frequently associated with **S. vesicarium.** A valuable plant for soil improving, producing abundant nodules on roots. Also excellent quail food. Easily distinguished from the more worthless plants of this group by the long pods, slightly curved; also quite tall and branching. Summer. (Frequently confused with **S. macrocarpa** Muhl or used synonymously.)

**S. vesicaria** (Jacq.) Ell. Bagpod

Perennial. Occurring throughout East Texas. Occasionally there are acres of perfect stands on old fields still fairly fertile. Does not grow well on poor soil. Its value is questionable from a soil building standpoint, and no clear records of wildlife use. Summer **(Glottidum vesicarum** Ell.)

**S. drummondii** (Rydb.) Corp Rattlebox

Perennial. Throughout East Texas on various soils, probably preferring moist, gravelly, tight sands. Of no value, but a weed in any situation. Poisonous (fruits) to some livestock; bears no nodules on roots. No wildlife record. **(D. drummondii** Ryd.)

**S. punica**

Specimen collected near Kirbyville, Texas. Reported by Parks to be abundant near Silsby. There is no record of this plant being found in the state, or recorded as growing here. Pods red, stem and flowers red. Because of its striking color said to be named so because of its reminder of the bloody wars of Rome and Greece. Much earlier fruiting than **S. drummondii,** which it resembles in some ways. Probably introduced.

24. Astragalus (Tourn) L. Milkvech

Species of this genus occur quite abundantly in various parts of East Texas on various soil types.

**A. leptocarpus** (T. & G.) Rydb.

Annual. Dry sandy soils to gray. Not too abundant in East Texas, deep sand of Houston County near Augusta, Texas. Spring. This group does not bear nodules, but in all probability some furnish food for wildlife. **(Hamosa leptocarpa** Rydb.)

**A. nuttallianus** DD.

Annual. Neutral to sandy soils; quite abundant throughout Eastern Texas.

**A. crassicarpus** Nutt. Ground Plum

Perennial. Rare in this area, occurring on dry prairies of Montgomery County. Probably quite abundant at one time, but continued grazing by cattle has tended to reduce the population of this plant. Utilized also by wildlife, and the pods have served as human food in times of stress. **(Geoprumnon crassicarpus** (Nutt.) Rydb.)

**A. reflexus** T. & G.

Biennial. This species occurs on deep sand, and occasionally on heavier soils. Collected in Houston County in early spring.

**A. intonsus** Sheldon

Collected in deep sands near Augusta, Texas. A white flowering species, rather striking. Remains green throughout the winter in this area. Flowers in early spring and sets large pods of fruit.

**A. obcordatus** Ell

Reported to occur in this area by Cory and Parks (2), not collected by writer. Spring flowering and fruiting. **(Tium obcordatum** Ell. Rydb.)

**A. distortus** (T. & G.) Rydb.

Quite abundant throughout East Texas on sandy soils and gravelly soils. Prefers dry situations, very early spring to early summer. Striking pink racemous flowering plants.

**A. carolinianus** L.

Reported to occur in this area by Cory and Parks (2). Spring and summer. (**A. canadensis** L.)

**A. engelmannii** (Sheldon) Rydb.

Another species reported to occur in East Texas but not collected by writer. Spring. (**Holcophacos engelmannii** (Sheldon) Small.)

**A. mexicanus** var. **trichocaly** (Nutt.) Fernald

Probably occurring sparsely along the westernmost boundary of area studied. Reported by Cory and Parks. (**Geoprumnon mexicanus** A. DC)

**A. plattensis** Nutt.

According to Cory and Parks (2) occurring in East Texas on dry soils. Spring and summer.

25. Psoralea L. Indian bread root

This genus occurs throughout East Texas on various soil situations, some species sparsely represented, some more abundantly; their values as a group is probably small from soil building or wildlife standpoint.

**P. floribunda** Nutt.

Occurring in sandy soils throughout East Texas; similar to **P. tenuiflora** of which it is considered a variety by A. Gray.

**P. digitata** Nutt.

Occupying a habitat ordinarily on heavier soils, probably not occurring eastward in the area studied. Spring and summer.

**P. esculenta** var. **bushii** Pursh. Indian Bread Root

Occurring in relative abundance throughout East Texas, on various soils. The species is a lower growing plant and occurs throughout Pine woods of this area. The large tuber is of value as wildlife food. Summer.

**P.pedunculata** (Mill) Vail.

Occurring spasmodically in this area. Found growing in Lufkin and I.G.N. Railroad right-of-way in south Houston County in abundance. Conspicuous when in bloom and quite attractive. Occasionally on moist soils. Spring and summer. **P. psoraloides** (Walt.) Cory.

**P. cuspidata** Pursh.

Reported in this area by Cory and Parks (2). Probably sparingly along the westernmost area studied, and on transition soils.

**P. obtusiloba** T. & G.

Probably similar habitat as the above mentioned species. Spring and summer.

**P. rhombifolia** T. & G.

Occurring sparsely throughout the area. Spring and summer.

**P. linearfolia** T. & G.

Reported by Cory and Parks (2) to be in this area of East Texas.

**P. tenuiflora** Pursh. Scurvy Pea

Occurs in deep sand in Houston County, and other parts of Eastern Texas. Summer.

**P. simplex** Nutt.

Occurring in deep Eastern Texas, pine soils and moist areas.

26. Amorpha L.

**A. paniculata** T. & G. Large Shrub.

A striking plant, large compound leaves and branching fruiting stems. Along river bottoms and creek banks. Montgomery County, Houston County and Angelina County. Summer. Probably visited by bees.

**A. fruticosa** L. Large shrub.

Fairly abundant in Neches River bottoms. Easily distinguished from **A. angustifolia** by the elliptic-oblong ovate blades. Some value as honey plant. Summer.

**A. angustifolia** (Pursh.) Boynton.

Shrub to 15 feet. Probably more abundant than the above species, farther westward naturally. More tomentose underneath leaves, blades acuminate. Also more receding toward petiole. Summer. Near streams.

**A. laevigata** Nutt.

Reported to be in this area by Cory and Parks (2). Summer.

27. Dalea Juss. (Parosela Cav. Small)

**D. enneandra** Nutt

Perennial. Found on dry prairies of Walker and Montgomery Counties. Spring and summer.

**D. nana** Torr.

Occurring in western part of area studied, probably not found eastward. Summer to fall.

**D. aurea** Nutt.

Reported to occur in this area by Cory and Parks (2). Spring to fall.

28. Petalostemon Perennial

This group is interesting from an ecological standpoint, three species occurring on sandy soils and three on calcarous, while one is found occurring more commonly on neutral soils.

**P. pheleoidium** T. & G.

Occurring throughout East Texas on sandy soils, widely separated areas. Dry bank on roadside in Polk County Pine woods area. Spring and summer.

**P. griseum** T. & G.

Occurring sparsely at scattered places over sandy soils of East Texas. Collected near Indian Springs, Houston County, on roadside, dry embankment. Spring and summer.

**P. purpureum** (Vent) Rydb.

Occurring abundantly on dry prairies of Montgomery and Walker Counties. Spring and summer.

**P. decumbens** Nutt.

Collected on prairie on alluvial soil in blackland outcropping in edge of San Jacinto County. Summer, rare.

**P. candidum** Willd.

Found on prairies and neutral soils of western Houston County, Walker and possibly Montgomery County. Summer, rare here.

**P. multiflorum,** Nutt.

Collected in late summer in Walker County near Huntsville, Texas on dry, eroded prairie; quite abundant in spots; same situations as **P. purpureum.**

**P. glandulosum** Coulter and Fisher

Reported to be in this area by Cory and Parks (2), no specimen collected by writer. Probably near S. E. border of area studied. Summer.

29. Ascheynomene L. Joint Vetch

**A. viscidula** Michx.

Perennial. Reported to occur in this area by Cory and Parks (2). Spring to fall.

30. Zorina Gmel.

**Z. bracteata** (Walt) Gmel.

Occurring rarely in Walker County. More abundant in Grimes County. One specimen collected by writer.

31. Stylosanthes SW. Pencil Flower

**S. biflora** (L) B.S.P.

Occurring all over East Texas on all soils and situations except cultivated fields. Good source of food for quail, etc. Spring and summer until late fall.

**S. hamata** (L) Taub.

Reported occurring in this area by Cory and Parks (2).

**S. riparia** Kearney

Also reported in this area by Cory and Parks (2).

32. Meibomia (Heister) Vail. Beggar Weeds, Perennials
(Desmodiam Desv.)

This genus of legumes while weeds in many situations, are of considerable value as wildlife food, especially quail. This group, because of its abundance, should not be minimized from this point of view.

**M. nudiflora** L.

Found growing fairly abundantly on one station in San Jacinto County near Twin Lakes, Cold Springs, Texas. This species is not reported as occurring in the state. One of the most interesting of this genus. Seeds eaten by quail, etc. Damp land in woods. Summer, probably to early fall. Rare.

**M. grandiflora** (Walt) Huntze.

Occurring in this area, probably not so common, however. Houston County. Summer to fall in sandy open woods. (**D. bracteosum** (Michx.)

**D. acuminatum** DC.

**M. pauciflora** Nutt.

Reported to be in this area by Cory and Parks.

**M. sessilifolia** (Torr.)

The second most abundantly occurring species of the genus in this area; found on practically all soils and situations, prairies, woods, etc. Another form, closely resembling this species from the leaf habits and number of loments, but otherwise sharply differing has been found growing on two widely separated stations. One north of New Waverly in Montgomery County growing along the I.G.N. Railroad right-of-way, and the other at the edge of the city limits of Lufkin in Angelina County. Both stations are dry, tight soils. It is huge in size and very robust of habit, far surpassing any others observed by the writer (**M. sessilifolia** in East Texas. It is not unusual to find specimens of this plant exceeding ten feet. In fact all specimens observed exceed six feet in height. One character definitely setting it apart from the typical of **M. sessilifolia** is the fact that this plant does not bloom before Sept. 1, whereas **M. sessilifolia** is the earliest fruiting in East Texas, blooming in the spring and early summer. Too, all the blossoms were white on this plant, whereas **M. sessilifolia** are purple to pink, turning bluish and occasionally lighter in color. No color of this is seen in the species under question. This plant does not have the branching habit as pronounced as in **M. sessi.** About 50 plants were counted on the New Waverly station and about 75 on the Lufkin station. It is possible that this may be a case of tetraploidy, but there seems to be a possiblity that this should be examined in the light of describing this as a variety of **M. sessilifolia.**

**M. canescens.** (L) Kuntze.

Fairly abundant in deep East Texas in moist woods. Summer to fall. Diboll, Angelina County. Texas.

**M. lindheimeri** Vail.

Summer and fall.

**M. paniculata** (L) Kuntze.

Quite plentiful along streams and wet and damp places. All over the area in woods and open places in the above described situations. Late summer and fall. Very fruitful.

**M. laevigata** (Nutt.) Kuntze

Fairly abundant throughout the sandy soils and open woods of Eastern Texas. Summer and late summer.

**M. rhombifolia** (Ell.) Vail

Occurring throughout the East Texas area studied, more abundant in open pine woods and retired fields. Deep sand. Summer and fall.

**M. viridiflora** (L) Kuntze

Quite variable in leaf size and shape and thickness. Occurring in sandy soils and open woods. Summer.

**M. dellenii** (Darl) Kuntze.

Less abundant than the above named, transition soils, not as common eastward, perhaps. Only three specimens collected in different stations. Summer.

**M. illinoiensis** (A. Gray)

Summer.

**M. rigida** (Ell) Kuntze

Not so abundant, only collected on two stations, in Houston County near Weldon and Augusta. Summer to fall.

**M. obtusa** (Muhl.) Vail.

Probably the most abundantly occurring native legume in this area. Almost any place in open woods and old fields. (**D. ciliare** (Muhl) DC.)

**M. purpureum** (Mill) Vail. Florida Beggar Lice

Naturalized. Found growing on one station east of Willis, Texas on the roadside of Cohn's Ranch. This is the only specimen observed. Not reported in literature as occurring in Texas. **D. tortuosum** (Sw.) DC.

**M. arenicola** (Vail.)

Reported in this area by Cory and Parks (2), not collected by writer. (**D. lineatum** (Mich) DC.)

**M. marylandica** (L) Kuntze

Reported by Cory and Parks (2), not collected by writer. (**D. lineatum** (Mich) DC.)

33. Lespedeza Michx. Bush Clover.

Lespedezas like Meibomias, are very abundant in Eastern Texas sands. As a genus these are of considerable importance from land building, wildlife, and pasture standpoint. All the native species are perennials.

**L. striata** (Thumb.) H. & A.

Intro. from Japan. Annual. This is the most abundantly occurring single species of legume in East Texas, and undoubtedly the most valuable. Although introduced, it is found naturalized throughout Eastern Texas on sandy and neutral soils. It is among the first succession plant to come in on poor, eroded, retired fields. It soon crowds out more valueless plants and establishes itself solidly. An excellent soil builder, excellent quail food and a fine pasture plant. This plant has rapidly spread over this area, coming in quite by chance with little or no aid from man. Comes up in March and remains until first frost; always producing a good seed crop. A remarkable plant of great value.

**L. repens** (L) Bart.

A valuable plant from wildlife standpoint. Not so abundant in this area, however. Late summer. Open woods, clay soil and transitions. Polk County, Texas.

**L. procumbens** Michx.

A very early flowering perennial lespedeza having two kinds of flowers. Sandy gravelly soils in woods. Very early spring and summer. Throughout Eastern Texas. Low growing.

**L. violacea** (L) Pers.

Sparsely scattered throughout E. Texas. Dry soils and open woods. Spring and summer.

**L. prairea** (McKenzie & Bush) Britton

Reported to be in this area by Cory and Parks. Probably on the prairies. Dry soils. Summer and fall.

**L. stuvei** Nutt.

Fairly abundant on transition soils, confused with **L. frutescens,** but easily distinguished by silky villousness underneath leaflets. Summer and fall. Houston County and Walker County.

**L. frutescens** (L) Britton

Probably the most abundantly occurring native lespedeza in the area. Dry red, sandy soils in open places and woods. Summer and fall.

**L. virginica** (L) Britton

Occurring on sandy soils and transitions clay to sand; roadsides, open woods on hillsides, etc. Fairly abundant in certain areas of Eastern Texas.

**L. sericea**

Perennial. Escaping from plantings in northern part of area under study. Apparently becoming naturalized locally. Late summer. Introduced.

**L. hirta** (L) Ell.

Flourishing in deep and in open woods in Walker County. The largest lespedeza in the area; conspicuous calyx lobes and large leaves. Summer and fall.

34. Rhyncosia Lour. Wild Bean. Perennials
(**Dolicholus** Medic.) Small

**R. minimus** (L) Medic.

Occurring on prairie outcroppings of East Texas in abundance. A slender procumbent to climbing plant. Valuable as soil builder, soil binder and wildlife food. Summer and fall.

**R. americana** Mill.

Occurring on sandy soils of Eastern Texas, slender, prostrate stems. Known as one leaf Rhyncosia. Spring and summer.

**R. tomentosa** (L) Vail.

Quite abundant on sand hills, open pinelands, with **R. latifolia,** which is similar. There is evidence that these two hybridize, many specimens are so similar that they cannot be distinguished. Spring and summer.

**R. torreyi** Vail.

Probably occurring in similar habitat as the above species.

**R. latifolia** (Nutt) Vail

Very abundant on sand hills and open woods. Valuable as wildlife food. Possibly hybridizes with **R. tomentosa.** Spring to fall.

35. Erythrina L. Coral bean

**E. herbacea** L. Perennial

Quite frequent throughout E. Texas in woods and moist areas and open woods. Abundant in Angelina County. A beautiful flowering plant in early spring to early summer; beans deep red. Of value as an ornamental in sandy soils.

36. Dioclea H.B.K.

**Dioclea multiflora** (T. & G.) C. Mohr.

A perennial climbing vine with large, glabrous trifoliate leaves.

In this area this plant frequently climbs several feet into trees. Some vines are almost upright, quite strong and stout. These are, of course, short, rarely exceeding two feet. When discovered growing in this area by the writer, it was late summer, and no blossoms were found, and relatively few fruits, since the fruits were, apparently, quickly deciduous. Insects seemed especially fond of the seeds. Evidence indicated, from the peduncle that it is a heavy fruiter. Evidently many of the plants set a fall crop. Many green, mature fruits were found in early October, even as the leaves were dropping. This plant occurs in abundance in Neches River bottoms above and below the river bridge on Highway 59 from Diboll to Corrigan. There is no record of this plant occurring in Texas in the literature or herbarium specimens. Found growing in among plants of **Wisteria frutescens** and on transition soils from bottom to hill among white-oak and other hardwood and pine associations. None is found on the hills or other uplands.
(**Dioclea boykinii** A. Gray)

37. Galactia P. Br. Milk Pea Perennial

**G. regularis** (L) B.S.P.

Occurring all over East Texas in sandy soils. Quite variable in leaf habits, and pubescence and fruiting peduncles. Considered an important food for quail, etc. Some value as soil binder and probably enriches soil. Spring until late summer. (**G. glabella** Michx.)

**G. volubilis** (L) Britton

Also occurring throughout Eastern Texas; on more fertile and moist soils in woods. Compared with **G. regularis** it has more pubescence and larger leaves, and usually, much longer fruiting peduncles. Spring and summer. (**G. pilosa** Ell.)

38. Amphicarpa Ell. Hog Peanut

**A. bracteata** (L) Fernald var. comosa (L) Fernald

Summer and fall. (**Falcata comosa** Small).

39. Bradburya Raf. (Centrosema Benth.)

**B. virginiana** (L) Kuntze Butterfly Pea

Perennial. Abundant throughout East Texas on sandy soils in the woods, pine and hardwood. A valuable quail food and probably soil builder. From early spring until late summer. Viney.

40. Clitoria L. Butterfly Pea Perennial

**C. mariana** L

Abundant in damp, fertile soils throughout the forest area of Eastern Texas. Possessing the most beautiful purple-blue flower of any legume in the area. A hearty plant, erect to viney. Valuable quail food. Late spring and summer.

41. Apios Moench. Ground Nut

**A. tuberosa** Moench. Ground Nut

Perennial. Frequent along streams and fertile creek and river bottoms. Maturing a long pod whose fruit is eaten by bob-white, etc. Superficially resembling **Wisteria macrostachya. (A. americana** Med.)

42. Phaseolus L.

**P. polystachyus** (L) B.S.B. Thicket bean.
Perennial. (**P. perennis** Walt.)

43. Strophostyles Ell.

Members of this genus are valuable for soil building and soil binding in eroded areas where abundant enough. Also excellent quail food.

**S. umbellata** (Muhl.) Britton Wild Bean

Perennial. Occurring over Eastern Texas, sandy soils to heavy. Frequently forming a very matted vine in gullies, etc. Of considerable value for erosion control and wildlife. Excellent quail food. Leaflets quite variable in shape and size. Summer and fall.

**S. pauciflora** (Benth.) S. Wats. Trailing Wild Bean

Perennial. Less abundant than the above, much smaller, linear leaflets, much shorter, weaker vine. Small fruits, but large for size of plant, variable. Some wildlife use. Sandy to gray soils. Summer and fall. (**S. leiosperma** (T. & G.) Piper

**S. helvola** (L) Ell.

Fairly common, but much less so than the first named species. Frequently confused with **S. umbellata,** but it has thinner leaves and it is more regular in symmetry.

44. Vicia L. Vetch, Pea Vine

**V. caroliniana** Walt.

Perennial.

**V. texana** (T. & G.) Small Texas Vetch.

Perennial. Occurring quite abundantly throughout East Texas or practically all soils. Slender, rather weak stems. Very early spring flowering and fruiting, open woods, etc.

**V. leavenworthii** (T. & G.)

Collected in several places by the writer. Transition soils to sand and gray. Early spring.

**V. ludoviciana** Nutt. Blue Vetch

Perennial. Occurring in sandy to gray soils. Difficult to separate from **V. leavenworthii.** Seed coloration important character. Early spring.

**V. micrantha** Nutt. Annual.

Found throughout Eastern Texas on a variety of soils, Walker, Angelina County. Very early spring.

**V. sativa** L. Common Vetch.

Introduced annual. Sometimes escaping and maintaining itself and reproducing where protected from grazing by livestock. Neutral soils of Houston County. Of value as a winter cover crop and soil builder. Spring.

**V. villosum.** Hairy Vetch.

Introduced annual. Similar to the above but quite hary. Occurring on similar situations with like habits. Spring. Same uses as above species.

**V. angustifolia** Roth.
Annual. Spring fruiting.

45. Lathyrus L.

**L. pusillus** Ell. Vetchling
Annual. Occurring scattered throughout Eastern Texas. Early spring fruiting. Sandy and gray soils. Walker and Angelina Counties.

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## EVOLUTION OF MYCOBACTERIUM TUBERCULOSIS

J. C. CROSS, Texas College of Arts and Industries, Kingsville.

Due to its importance as a pathogen the tuberculosis organism has been studied more from the standpoint of its pathogenicity than from that of its evolution. This paper deals with the organism as a derivative of a non-pathogenic soil bacterium that has made its way to the human body by a series of steps, finally becoming a pathogenic parasite. Experimental evidence is given in support of the theory.

TAXONOMIC STUDIES ON THE SPIDER GENUS, DICTNYA. SARAH E. JONES. Texas State College for Women. No abstract received.

## THE SPONTANEOUS OCCURRENCE OF AMPHIPLOIDY IN SPECIES HYBRIDS OF COTTON

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Without treatment, a fertile boll containing five seeds was produced on an otherwise sterile F. hybrid of two wild species of cotton, **Glossypium davidsonii** and **G. anomalum.** Both are diploid species containing 13 pairs of chromosomes, and are indigenous to lower California and to Africa, respectively. Cytological analysis of F2 and F3 plants shows the presence of 52 chromosomes, usually forming 26 pairs, as in the natural amphidiploid species **G. hirsutum,** which in cludes our upland cultivated cottons. Except for the increased size of the blossom of the new amphidiploid, the flower and leaf characteristics of the F1, F2, and F3 are intermediate between those of the parental species. Although fully self-fertile, the new hybrid fails to cross with many species with which **G. davidsonii** is incompatible.

A second case of spontaneous fertility was found on a triploid F1 hybrid between **G. hirsutum** and **G. armourianum,** a wild 13-chromosome species from lower California. An F2 plant analyzed cytologically was found to contain the hexaploid, hence doubled, number of chromosomes.

The presence of more than one fertile seed in each boll suggests that the change to the allopolyploid number of chromosomes occurred in both cases in the bud primordia which produced the fertile flowers and bolls. The two cases are of interest because they represent instances of spontaneous doubling such as must have occurred in nature years ago to produce the American amphidiploid species of cotton.

## A FIELD STUDY OF THE DYNAMICS OF MAMMALIAN POPULATIONS *

W. FRANK BLAIR, University of Texas, Austin

Two plots of blue-grass association, comprising 2.8 and 3.8 acres, respectively, were trapped at regular intervals over a period of five years (1938 to 1942) in Livingston County, Michigan. Live traps were used, and all small mammals caught were marked by toe clipping and ear punching, recorded and released. Nine species of small mammals were recorded. Prairie deer-mice **(Peromyscus maniculatus bairdii),** wood-mice **(Peromyscus leucopus noveboracensis),** meadow voles **(Microtus pennsylvanicus pennsylvanicus),** and jumping mice **(Zapus hudsonius hudsonius)** comprised the bulk of the small mammal population. Seasonal lows in population density usually occurred in the spring with an increase to a seasonal maximum in the fall. The low densities in spring are attributable to lack of breeding during the winter months rather than to increased mortality. Annual fluctuations were greatest in the meadow vole, which varied in density from an estimated maximum of only 0.2 individuals per acre in 1939 to an estimated 29.8 per acre in 1942.

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* Published as a Contribution From the Laboratory of Vertebrate Biology, University of Michigan.

An average ecological life span of nearly five months was indicated for the deer-mouse and one of over four and one-half months was indicated for the wood-mouse. This is short by comparison with the physiological life span of these species of over three years and as long as eight years in captivity. Invasion of relatively unfavorable habitats by meadow voles and wood-mice occurred at times of maximum abundance.

## THE ASSAY OF 17-KETOSTEROIDS AS A DIAGNOSTIC AID IN ENDOCRINE PROBLEMS *

J. K. LAMAR, Medical Branch, University of Texas

15 min. (Slides)

Androgens, the endocrine modifiers of male secondary sex characters, are excreted in urine in the form of neutral 17-ketosteroids (17-KS), organic compounds having a phenanthrenecyclopentane nucleus and specifically a ketone group on carbon atom 17. By color reactions typical for this grouping the 17-KS excretion rate can be assayed, and thus some measure of body androgen level can be obtained. This method has practically replaced the older bioassay technics of Pezard (1911) and of Gallagher and Koch (1932) for clinical studies. It is now known that 17-KS excretion rates start off at practically zero for babies, and very gradually increase with age and growth, until a sudden spurt in excretion rate up to almost adult levels occurs during puberty. Excretion rates for men are in general slightly higher than for women, and there is evidence for the belief that the adrenal and testicle are the sites of formation of the parent compounds. Excretion rates may vary somewhat from day to day, and certainly there are significant differences in results from different extraction and assay techniques. However, if one technique is used throughout, it is found that excretion rates are extraordinarily high in association with corticoadrenal hypertrophy and corticoadrenal carcinoma, adrenal rest tumor and metastases, as they are also in hypoproteinemia of pregnancy and in Hand-Schuller-Christian disease, for another reason. Excretion rates of 17-KS are extraordinarily low in association with Addison's disease, hypothyroidism, panhypopituitarism, male castrates, eunuchoids and males with liver cirrhosis, as well as in children (below age 12) showing retarded growth and development. Therefore, in recent years the study of 17-KS excretion rates has found a place in clinical endocrinology, to be used along with all the other laboratory and clinical methods of diagnosis.

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* This work has been aided by a grant from the Johnson & Johnson Research Foundation, New Brunswick, N.J.

The assays reported herewith were done by the colorimetric (m-dinitrobenzene) technique of Kurzrok and Sachs as modified for the Klett-Summerson photoelectric colorimeter, after extraction by the technique of Consolazio and Talbot (1940). Blanks were used in such a way as to eliminate the effect of extraneous color (method of Talbot, et al, 1940), so that no adsorbent is used in the extraction procedure. This may account for the generally higher excretion rates for the normal controls. In all, 110 assays on 28 cases are here reported, as averages for the individual case. The range of excretion rate for 24 hours was 13.1 to 18.3 for normal males, and for normal females 7.7 to 9.6 mg. In 7 cases of possible male endocrinopathy the range was 10.2 to 35.4, and one male, age 7 yrs., with macrogenitosoma praecox, averaged 16.3 (11.3 to 24.6 mg.); his twin sister averaged 5.9 mg. In one case of female macrogenitosoma praecox, at 6 months of age the average was 2.1 mg., at age 3 yrs. the rate was 21.2, and shortly after adrenal exploration and removal of the major part of one adrenal, the rate was still 18.7. In 3 cases of possible female endocrinopathy the excretion rate was 9.3 to 31.3 mg. One patient with carcinoma of the head of the pancreas and questionable enlarged adrenal averaged 7.5 mg. Two cases of Cushing's syndrome averaged 8.0 and 21.4 m., and the latter averaged 10.9 mg. after treatment. In 7 cases of extraordinary hirsutism the excretion rate ranged from 7.7 to 32.8 mg. No cases of adrenal carcinoma have been found in this series.

## The Effect of the Protein of the Diet upon Energy Metabolism

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Earlier studies (1) on the relationship of the diet to the production of fatty livers suggested that the metabolism of such animals might be profitably investigated. Several observations indicated an increased rate of catabolism in the animals on low protein diets. First, these animals barely maintained their initial weight although they ate well; and second, there was a quite noticeable absence of the normal body fat stores when opened for removal of their livers.

Kleiber (2) has stated that "apart from influences on digestibility and excretion, a dietary deficiency can lower the efficiency of energy utilization in three ways: (1) by decreasing the level of food intake, (2) by increasing the basal metabolic rate, and (3) by increasing the calorigenic action of the food."

Most dietary deficiences decrease the food intake, but such was not the case in our experiments if amounts are expressed per unit of metabolic body size (2). Forbes and coworkers (3) and Hamilton (4) have shown that there is an increased heat loss on low protein diets. This undoubtedly was true in our studies. Both groups of investigators reported that the composition of the diet did not affect the basal metabolism. However, the post absorptive metabolic rate appears to be elevated in our animals previously on the low protein diet. Horst, Mendel, and Bendict (5) as well as Black (6) and Ashworth (7) have found the basal rate (fasting state) to be lower than that of the animals which had had higher protein intakes, and we would expect the same to be true of the animals in our studies.

The first suggestion of an increased metabolic rate in the animals on a low protein diet came from a study of their carbohydrate metabolism through glucose tolerance tests (1) and liver glycogen determinations (8). It ws found that, after receiving a diet low in protein and lipotropic factors and high in fat, the fasting rats have a markedly decreased glucose tolerance, although the fed animals have significantly greater liver glycogen stores. The effect of the protein of the diet upon the rate of removal and storage of glycogen in the liver is shown in Table I. The very rapid depletion of the liver glycogen on fasting, and its slow replacement when fed glucose, are in line with an increased rate of utilization of carbohydrate in these animals in the post absorptive state. The lowered tolerance might be expected after the rapid depletion of the liver glycogen during the early fast—comparable to the decreased tolerance associated with a longer than overnight fast.

The marked early fasting ketosis in the animals previously on a low protein diet could be associated with the rapid depletion of the glycogen stores due to an increased rate of utilization of carbohydrate. Another explanation of this condition has been on the basis of decreased protein stores and hence a decreased gluconeogenesis (9). Previous investigations (10) indicate that this fasting ketosis is directly related to the previous protein intake. However, an amount of glucose equivalent to the protein catabolized by the animals on the higher protein diet did not appreciably affect the ketonemia (11).

Again, it appears that an increased utilization of the carbohydrate, with a rapid depletion of the carbohydrate reserves, and then an increased use of fat to meet the energy requirements, might better account for the increased ketonemia than a lack of protein stores for gluconeogenesis.

There was the possibility that the lack of body fat stores and failure to gain weight were associated with a decreased food intake rather than an increased rate of oxidation of the food stuffs in these animals. Data from 8 previous experiments, summarized in Table 2, were examined to decide this point. The food intake is similar in the two groups if caloric intake per average unit of metabolic body size is considered. However, it is true that the animals on the low protein diet ingested a smaller absolute amount of food since they barely maintained their initial weights while the controls made appreciable weight gains. The failure to increase their weight while ingesting a similar number of calories per average unit of metabolic body size, supports the contention of a greater calorigenic effect of the low protein diet. Additional evidence to support this suggestion was obtained in one balance study (12). In experiment G. 1-4, the animals on the low protein diet stored only 8 per cent of ingested calories while the controls stored 20 per cent of their caloric intake under comparable conditions.

Further evidence regarding the possible increased rate of catabolism in these animals under varying conditions could be obtained from metabolic rate determinations. It has been shown that a decreased basal metabolic rate is associated with protein deficient diets (5, 6, 7) but evidence regarding the metabolic rate of the unfasted animal in the post absorptive state is not too conclusive. Our preliminary oxygen consumption data on a few rats is not convincing, although the trend is toward an increased rate of catabolism, post absorptively, after low protein diets. The number of animals was too small and they apparently were not sufficiently trained for the experiment. Further studies are in progress.

**Summary.** A more rapid catabolism of reserves in the animal fed a low protein diet is suggested by the following facts. First, a more rapid removal of liver glycogen occurs on fasting and it is more slowly replaced when the animal is fed. Second, a consequent earlier fasting ketosis develops. Third, the animals fail to gain weight while ingesting a caloric intake similar to that of the controls. This could at least in part be associated with an increased catabolism as well as an increased calorigenic action of the food.

These facts again emphasize the importance of adequate amounts of protein in the diet and that such amounts will increase the efficiency of energy utilization in animals receiving well balanced diets.

### Relation of Protein Intake to Utilization of Food

Summary of data from 8 experiments in which were recorded the weights and food intakes for 21 day periods. All diets were similar to those described previously (10).

| No. of rats | Initial Wt. | Gain in Weight | Protein in Diet | Diet Calories per dm$^2$ per day |
|---|---|---|---|---|
| | gm. | per cent | per cent | Cal. |
| 68 | 209 | 2.9 | 5 | 18.8 + or – 0.8 |
| 68 | 203 | 24.8 | 20+ | 16.8 + or – 0.6 |

| | | |
|---|---|---|
| Exp. G. 1-4<br>Similar intake<br>cal/dm$^2$/da. | Low protein diet | 8% Cals. stored |
| | High protein diet | 20% Cals. stored |

**The Effects of Low Protein Diet upon Liver Glycogen Levels**

All animals received the special diets (8) for 21 days. The liver data were calculated on the bases of 100 gm. body weight and the glycogen level of controls considered 100 per cent. The fed animals were given 3.5 gm. glucose per kgm. body weight and liver glycogens determined 3 hours later.

| No. of rats | Protein in Diet | Liver Glycogen | | | |
|---|---|---|---|---|---|
| | | Fasted | | | Fed |
| | | 0 hrs. | 12 hrs. | 24 hrs. | 3 hrs. |
| | | per cent | per cent | per cent | per cent |
| 7 | 30 | 100 | 46 | 40 | 142 |
| 7 | 5 | 239 | 28 | 24 | 92 |

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## QUANTITATIVE EFFECTS OF PITUITARY EXTRACTS AND ADRENALINE ON COLOR CHANGES IN CERTAIN AMPHIBIANS AND REPTILES

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Intramuscular injections of a sodium hydroxide extract of mammalian pituitary gland and solutions of adrenalin chloride were used in experiments on color changes in some reptiles and amphibians. The minimum concentration of these solutions needed to produce color change was determined and the results compared on a basis of body weight and the changeable surface area. Pituitary injections produced the expanded state of the melanophores, or the dark color phase. Adrenalin injections produced the light color phase.

The changeable surface area was found by tracing the color pattern of a skinned animal and marking the changeable and non-changeable area. A smooth copy of this was made and the changeable areas were cut out and weighed. The area was calculated from the weight per square centimeter of the paper used.

Pituitary and adrenalin injections produced color changes in the following animals: **Anolis carolinensis** Voight, American chameleon; **Phrynosoma cornutum** (Harlan), horned lizard; **Sceloporus undulatus hyacinthinus** (Green), fence lizard; **Rana pipiens** Schreber, leopard frog; **Hyla cinerea (Schneider)**, green tree frog. The amounts of pituitary extract or adrenalin which caused color changes were consistent among individuals of the same species.

A closer correlation exists between the amount of pituitary extract required to cause expansion of the melanophores and the area of changeable surface of the animals than between the amount of pituitary extract and their body weight. Compared on a basis of body weight and the changeable surface area, **Phrynosoma** and **Sceloporus** are more sensitive in their reactions to adrenalin injections than are **Rana** and **Hyla.**

Injections of pituitary extracts or adrenalin did not produce color changes in **Crotaphytus collaris** (Say), mountain boomer; **Cnemidophorus sexlineatus** (Linnaeus), race runner; and **Holbrookia texanum** (Troschel), spotted lizard.

## Vitamin A, Carotene and Reduced Ascorbic Acid in Composite Food Samples From A College Dormitory[1]

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The vitamin A, carotene, and reduced ascorbic acid techniques for the analysis of composite food samples were developed when satisfactory recoveries of 101%, 99% and 103%, respectively. The foods comprising the main course of each meal were macerated in a Waring Blendor, and then a suitable fraction removed for each analysis.

The results obtained showed for ascorbic acid that unless slaw was part of the main course the main courses as such did not contribute over 15 mg. per day to the diet. The breakfasts were totally lacking in ascorbic acid except for the fruit. The selection of the fruit is of utmost importance in order to assure a good intake of that vitamin. The salads, either vegetable or fruit, gave a range of 5 to 8 mg. of ascorbic acid per serving. The carotene content of the diets was primarily due to the selection of the vegetables and fruits in the main courses, whereas the vitamin A of the diet increased with the increased use of milk, eggs and milk puddings. Because of the high carotene content of some of the diets, it is believed that some human utilization studies of such diets should be investigated.

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[1] Financed in the main by the Special Research Fund granted North Texas State College by the 49th Legislature.

[2] Graduate Research Assistant.

# Preliminary Report of Carotene, Vitamin A and Ascorbic Acid Absorption in Human Subjects on a Self-Selected Diet[1]

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The purpose of this study was to obtain the absorption values for vitamin A, carotene and ascorbic acid by college students. The food, feces and urine were each analyzed, and a balance was set up. Due to the inability to obtain a sufficient quantity of GDH a complete return on vitamins A and D is not included in this preliminary report. The food was collected at each meal in the same size serving as being served the student. These servings were put into wide-mouth, quart size, Ball jars containing 1% metaphosphoric acid to prevent the destruction of ascorbic acid. The food from each meal was macerated in a Waring Blendor, and then a ¼ of each meal for a day was put into a common jar and retained for all analyses other than ascorbic acid, for which 1/20 of the diet was employed. The diets were planned by the girls, following the Basic Seven and showed a much lower ascorbic acid content on analysis than had been calculated. Consequently, it is questioned whether or not those employing a specific formula for the planning of meals obtain sufficient ascorbic acid in the daily diet.

The urine was collected in 24-hour samples in dark bottles containing 75 ml. of 5N sulfuric acid, 5 ml. of toluene and 1 ml. of 8-hydroxyquinoline. These samples were analyzed daily for ascorbic acid. The feces were also collected in wide-mouth jars, pint size. A marker was used in the beginning and the end of the test period. The individual samples were macerated and then combined into one homogenous mass, from which the final analyses were made. The methods employed in the preceding paper were used in the analyses for the three vitamins.

At the time of this report only the balance for ascorbic acid had been obtained. This showed that 8 of the 11 girls completing the study had the normal minimum value of 15 mg. of ascorbic acid in the urine daily regardless of the slight fluctuations in the diet. Carotene values of these diets again showed a relationship to the type of fruit and vegetable included in the diet, the vitamin A again being related to soups, milk, milk puddings, etc., which contain eggs. This study will be completed in the near future.

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[1] Financed in part by the Special Research Fund granted North Texas State College by the 49th Legislature.

[2] Graduate Research Assistant.

# THE FERMENTATION OF COFFEE

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This is not a new paper, or at least this is not a new original paper, but a summary of data recollected by the author during his work for the Coffee Association in the Republic of El Salvador from 1941 to 1944.

Most of the content was printed before in Spanish in Mexico and El Salvador, and is included only for the purpose to clarify some problems practically unknown outside of the coffee growing countries.

"Coffee Fermentation" is an important part in the process of "Coffee Curing" by the so-called "Wet" method.

There are two ways of curing coffee. The "Dry" process where the fruit (called the grape or cherry) is brought to the patios and put on big floors made of bricks or cement and dried until the convenient point of humidity is reached, and the "Wet" one, more complicated, and composed of four different steps:

1) The **removing of the pulp** in the pulper,
2) The solubilization by **fermentation** of the remaining mucilage which sticks to the endocarp (called parchment),
3) The elimination by **washing** of the products of fermentation and most of the microorganisms grown during the preceding process, and
4) The **drying** in the "patios" alone or in the "patios" first and in special dryers later until the humidity drops to 12 or 13%.

The coffees prepared by the second method, called "washed or sweet" coffees, are higher priced than the product made by the dry process. This last kind of coffee received the name of "corriente" in Latin America, which means more or less regular, and is also known as "unwashed" coffee.

It is true that the difference in price mentioned before doesn't mark an inferiority in this kind of coffee, but depends mostly on the scarce production of sweet coffee, compared with the bulk of the "unwashed" coffee exported, mainly by Brazil.

The so-called "American Coffee," practically the national beverage of the United States, is a blend of different kinds of these products; different not only by the system of curing, but also by the altitude, where the coffee trees or shrubs are grown. These blends, which vary slightly in taste cannot be prepared from only "sweet" coffees and there were years when a crop failure in Brazil raised the price for unwashed coffee to a height surpassing that for the "sweet" product. In other words, the sweet coffee is not a better kind but a different one, compared with the "unwashed" bean. The appearance and the taste of the two kinds can be easily appreciated by experienced persons.

The subjective method is in use and the professional coffee-taster depends for his job on this, rejecting the use of the still imperfect chemical analysis.

The American market gives a major attention to the taste; contrary to this, European buyers consider it very important to have a "good-looking bean." Before the war the European market controlled by Germany accepted as high priced coffee only a product which passed through a polishing process.

The difference in taste of the two kinds of coffee is a well established fact. For many years the general opinion of coffee technicians and growers has been considered as responsible for the changes in the phase of fermentation. This explains the reason that the last 30 or 40 years has seen a certain amount of investigation devoted to this step of coffee curing.

It is necessary to point out that coffee curing is far from a scientific process; it was developed slowly as an empirical synthesis of a series of steps, many of them negligible and even harmful, but all made with the purpose of preparing a product accepted on the foreign markets.

During the fermentation the mucilage which remains on the parchment, and is composed principally of pectins and similar substances, is made soluble by action of a group of enzymes. The duration of the normal process varies between 15 and 24 hours. A delayed fermentation is dangerous because the bean is easily spoiled, acquiring the peculiar taste and odor of the so-called "fermented coffee" which is practically worthless for export. Many secondary processes are observable aside from the hydrolysis of pectins, like the formation of ethanol, lactic, acetic and butyric acid. For some time investigators failed to give the needed attention to the principal process of the disintegration of pectins, being attracted by the fermentations of sugar which clouded the general picture. The secondary reactions like the butyric and acetic fermentations are often responsible for the spoiled product.

Lilienfeld-Toal and Perrier in Brazil and Fritz in El Salvador showed that the unique purpose of fermentation lies in the solubilisation of pectins, but the first two failed to make the deduction that this step cannot be held responsible for the difference between the "washed" and "unwashed" coffee.

The different necessary enzymes are present in the pulp of the coffee-cherry or are supplied by molds or bacteria which develop swiftly in the fermentation tanks. It is still a matter of discussion whether the presence of these microorganisms is necessary for the hydrolysis of pectins or if the enzymes of the pulp are sufficient to produce the needed solubilization. However, in each case the molds and bacteria raise the temperature of the tanks speeding in this way the reaction.

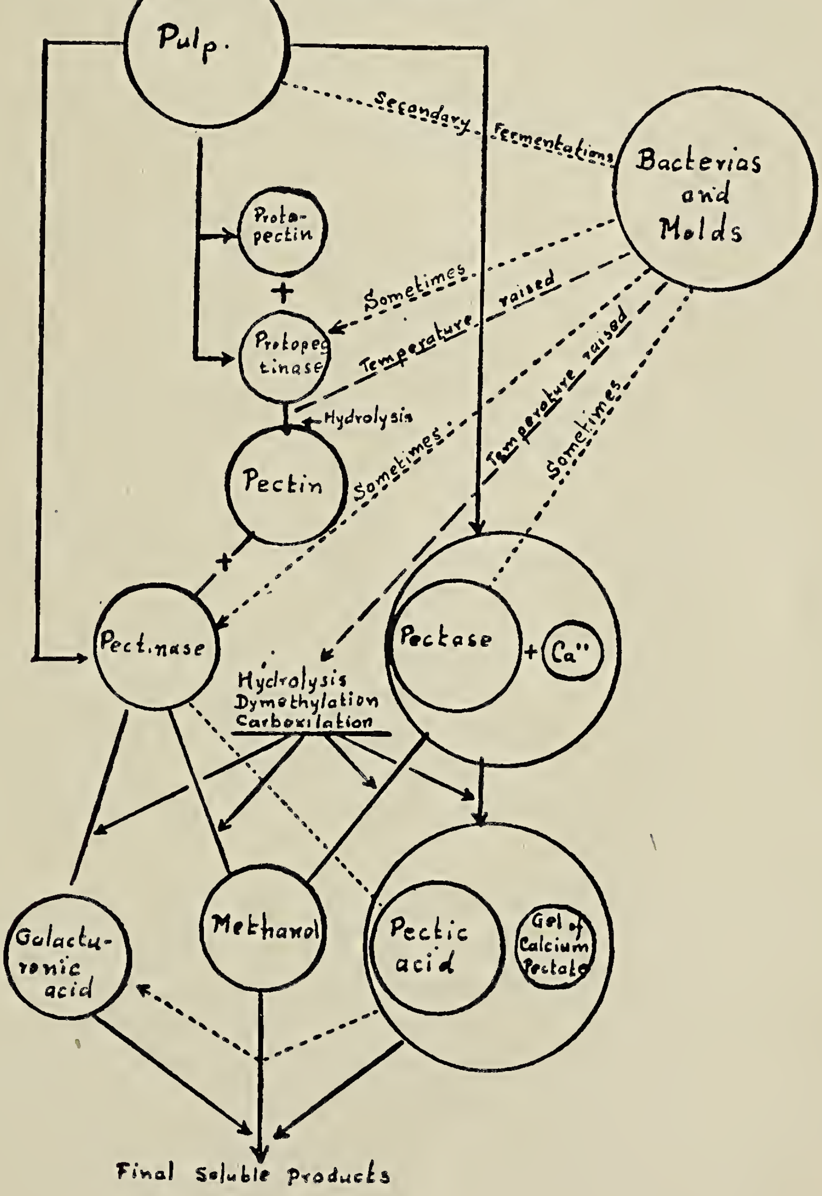
Scheme I gives a general idea of the disintegration of the pectins in the mucilage. The process develops more or less in this form.

The protopectin in the presence of the enzyme protopectinase is hydrolyzed into pectine. The pectine by demethylation and a partial or complete carbolation is transformed into pectic acid, galacturonic acid and methanol. The formed insoluble pectic acid is swiftly transformed into galacturonic acid. All the end products are soluble in water.

At least the presence of two enzymes, the pectinase and the pectase are necessary for these reactions, the second needing the calcium ion as a coferment. It is also possible that the formation of the tetragalacturonic acid takes place first, this being broken down by a different enzyme, pectolase.

The secondary process in a good fermentation must be confined to the production of ethanol and lactic acid which does not cause harm to the bean. The temperature is a little higher than the surrounding air and the pH drops from 6.8 or 6.7 to a point between 4.2 and 4.5 when the end point is reached. In practice this point is determined by squeezing a small portion of coffee. If the grains are easily separated from the mucilage, the coffee is "ripe" for washing.

Scheme I



Once it was established that the fermentation served only for the purpose of eliminating the mucilage and did not interfere with the changes in the taste and appearance of the bean, it was necessary to find a new explanation for the difference between the "sweet" and the "unwashed" coffee.

Martin Case in Kenya was the first who gave a new interpretation for the changes in the coffee caused by the wet method, suggesting an oxidation and reduction taking place below the parchment directly in the bean. He timed this process with the step of the pectin fermentation, pointing out that the best results are obtained by covering the coffee in the fermentation tanks with water.

This hypothesis concerning the mechanism of the reaction can be considered as probably correct. On the other hand, it is easy to demonstrate that coffee assumes the characteristic of "sweet" without any fermentation, if after the removing of the pulp the grain, still covered by the parchment, remains in contact with a sufficient quantity of water for at least a half an hour or slightly more. Practically speaking the first changes take place during the first step in the pulper and in this way Case's timing must be disregarded.

The best hypothesis is to accept a kind of Cannizaro reaction directly in the bean, where enzymes still unknown oxydize one substance and reduce another.

It is also possible that the hydrolytic process takes place at the same time. Until now, no one has worked on the finer mechanisms of the changes from "unwashed" to "sweet" coffee.

The elimination of the mucilage still remains a necessary step in the "curing of the coffee" because without this operation secondary products would form during the drying in the "patios", in this way spoiling the bean.

It is easy to understand why, accepting fermentation as unnecessary, that many experiments were made to find out a mechanical or chemical way for destroying the mucilage.

Ten to twelve years ago the German factory of Krupp introduced the "Roeng" pulpers, which mechanically eliminated the complete pulp. In practice this machine failed since it needed too much power and water (the last a serious problem in many places, and left in the furrow of the bean small quantities of mucilage which often fermented, spoiling the product.

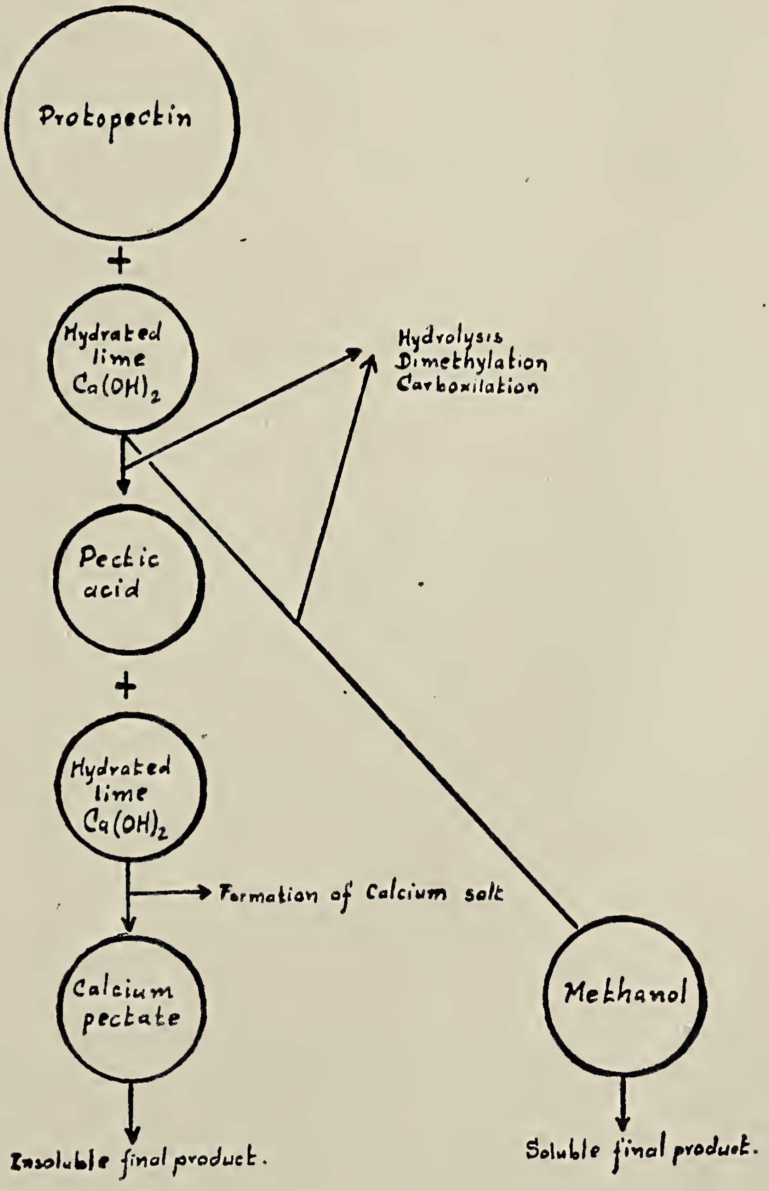
Another system of destroying the mucilage with chemical compounds (mostly weak alkalis) was also given up on account of the large quantities of water needed to wash out the remaining soluble chemicals. In 1943 the author introduced a new method using lime to precipitate the pectins. The formation of an insoluble calcium pectate makes the mucilage unable to ferment and the resulting coffee can be dryed without washing. Of course, if the producer has enough water he can still mechanically eliminate the calcium pectate which has a very weak adherence to the grain.

The system, adopted experimentally in districts with poor water supply, produced coffees not distinguishable from those prepared in the orthodox way.

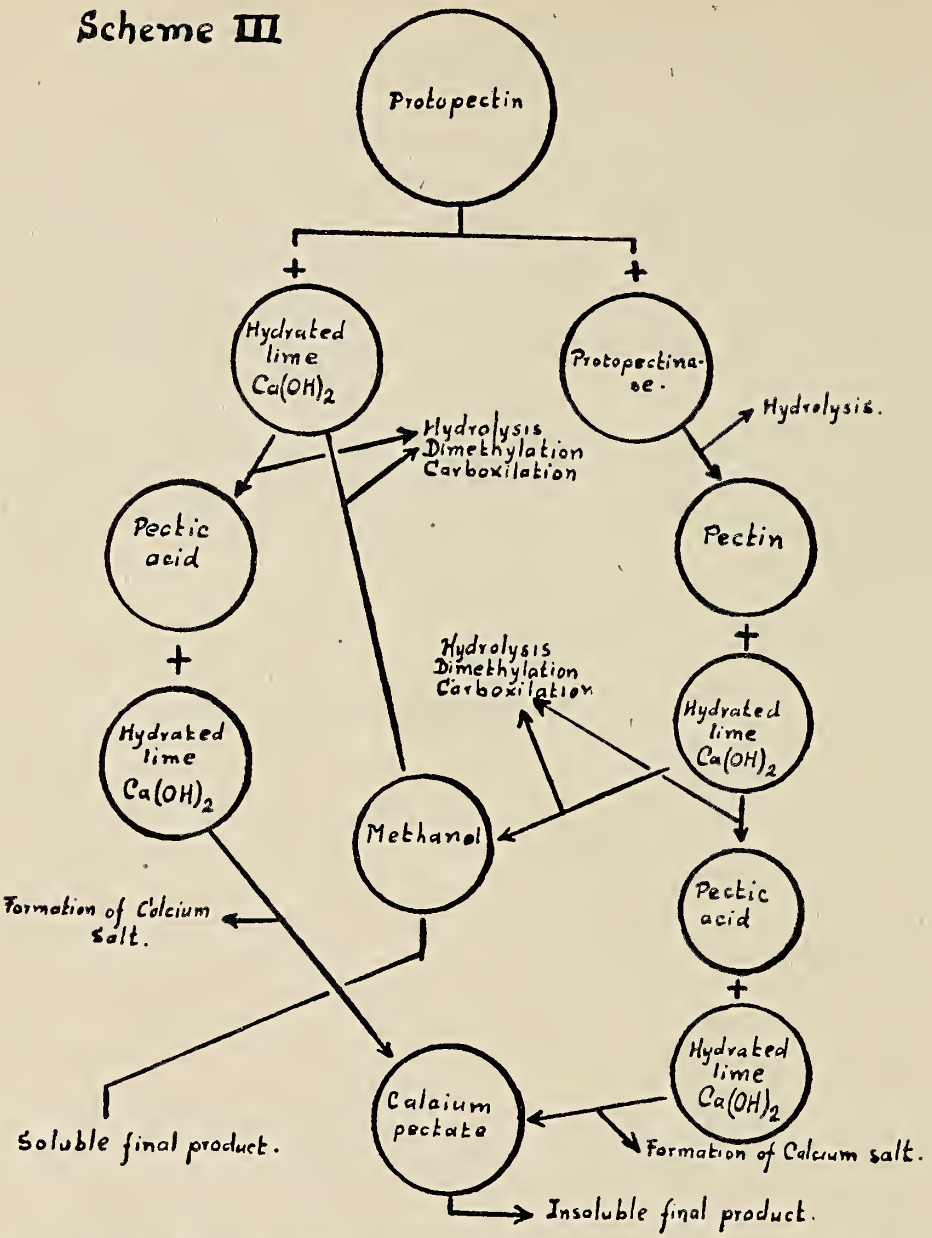
The former Technological Institute of El Salvador, taking charge of the experiments, dispatched several samples prepared at the **same** time from the **same** sample of cherries, in part prepared by the fermentation and in part prepared by the lime process, to the most important factories for roasting coffee in the United States. None one was able to find any appreciable difference. One factory not knowing that half of the samples were prepared by fermentation, suggested that in future experiments it would be useful to send the two types of coffee to be tested at the same time, thus giving absolute approval to the new system.

The chemical process, which takes place can be explained by the next two schemes: the first for strong and the second for weak solutions of lime. Instead of the strong solution, dry hydrated lime can be used in the process.

Scheme II



Scheme III



It is true that the lime process gives not a better, but an equal coffee and the changes in the system mean new investments for many curing factories, but from the sanitary standpoint the elimination of fermentation and washing must be considered as an improvement. (Only one who knows the "smell" of the Beneficios or curing plants short of water, and can observe the pollution of streams during the crop, will be able to appreciate in full scale the changes that the lime-procedure can bring, resolving in this forman important health problem in many coffee growing countries of the Western Hemisphere.

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## EFFECT OF ISCHEMIA OF THE NERVE ON THE RESPONSE OF THE NERVE-MUSCLE PREPARATION IN THE CAT

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It has been previously reported that ischemia caused by occluding the femoral artery in the cat results in an increased response of the tibialis anticus muscle when its nerve is stimulated by weak shocks (Porter and Callahan, Proc. Amer. Physiol. Sec., 2:38, 1943, and Porter and Taylor, Ibid. 4:56, 1945). The effect is not seen in curarized muscle.

We now find that ischemia of the nerve alone results in the same increased response of the muscle. A glass electrode is used on the nerve. Circulation of blood in the minute arteries of the nerve can be seen through the glass with a dissecting microscope. The nerve is stimulated once in three seconds with single shocks and the resulting muscle twitches are recorded on a drum. The arteries supplying the nerve are located and clamped when a test is to be made. The circulation in the nerve is observed to cease. After a latent period of 1 to 2 minutes, the shocks to the nerve result in increased contractions of the muscle, often several times the original height. Upon removing the clamps after a few minutes the blood is observed to resume flow in the nerve and the muscle contractions almost immediately diminish in height or cease altogether. Some minutes later they usually return to their original height.

The mechanism of these unexpected results is obscure. It would appear that maximum response of nerve requires a hydrogen ion concentration slightly greater than that of normal blood, as has been suggested for both striated and heart muscle.

## THE DECEREBRATE GOAT

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It has long been known that section through the mid-brain of many of the higher animals brings on a state of rigidity which is due to an over-activity of the postural or anti-gravity muscles. The writer recently had the opportunity to perform the operation on several goats at the Behavior Farm of Cornell University.

The goat goes under ether easily but the tracheal cannula should be inserted promptly, since the goat secretes a large amount of saliva and mucous which interferes with breathing.

It is necessary to cut off one horn at the base to permit trephining the skull. Rigidity begins at once after sectioning the brain and in an hour or so is extreme, all four legs rigidly extended, head up and sometimes the tail. Leaning against a fence, the animals will stand in a lifelike position for many minutes. The rigidity persisted six to eight hours of the day of operation, but the animals were always found dead the next morning.

The preparations were made for the purpose of comparing the rigidity with that developing in certain goats when used for the study of conditioned reflexes. Prof. Liddell of Cornell will publish on this point at a later date.

## THE MECHANISM OF TRANSAMINATION AND THE PREPARATION OF GLUTAMIC-ASPARTIC TRANSAMINASE

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The action of the transaminase enzymes was discovered by the Russian biochemists, Braunshtein and Kristman, in 1936. Their importance lies in their rearrangement of amino acids into forms which can be used for the synthesis of protein in the body. This rearrangement is presumed to take place in the following manner: amino acids combine with pyridoxal to give first a B6 Schiff base which in turn splits into the corresponding keto acid and pyridoxamine; keto acids combine in the same way with pyridoxamine to give corresponding amino acids and pyridoxal. We are particularly interested in glutamic-aspartic transaminase which catalyzes the reaction: Glutamic acid + oxaloacetic acid — keto-glutaric acid + aspartic acid. Equilibrium is 75% in the direction of aspartic acid.

For the study of this reaction we needed quantities of the purified enzyme, and we found the following procedure to be both satisfactory and quick.

1. Homogenized pig heart was stirred in 3 volumes of acetone twice and in ether once and dried in a vacuum desiccator. This treat-

ment serves the purpose of removing proteolytic enzymes which would destroy transaminase in fresh tissue extracts, and therefore allows the dried product to be kept for several weeks.

2. The dried product is extracted with secondary phosphate for 30 minutes at 55°C. The solution is filtered, cooled, and adjusted to pH 4.5 with 1N acetic acid. This precipitates a great percentage of the inert protein which can be centrifuged off. The supernatant is adjusted to pH 7.5 with 1N NaOH.

3. The solution is then fractionated with saturated ammonium sulfate solution into two fractions, 50% and 72% saturation. The precipitate of the 72% fraction is filtered off and redissolved in a small amount of phosphate buffer, pH 7.5.

4. This solution is refractionated with saturated ammonium sulfate solution into four fractions. Depending on the contaminations present in the source material, the greatest activity will be found in either the second or the third fraction.

5. The fraction with the greatest activity is diluted to 50 ml., brought to pH 5.8 with 1N acetic acid, and treated with alumina in fractions of 5 ml., 10 ml., and then 100 ml. The alumina is first washed with water and then eluted with M/25 phosphate buffer, pH 7.5 for an hour. It is centrifuged off and the supernatants tested. The greatest activity and purity will be found in the supernatant from the last fraction of alumina.

This solution can be used for all tests needed to clarify the picture of the mechanism of transamination.

## STUDIES OF NUCLEOSIDE DEGRADATION

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In recent work on nucleoside metabolism we examined many ribonucleosides prepared in this laboratory. It was observed that nucleosides found in the animal kingdom are readily metabolized by liver enzyme, while plant nucleosides are not. In this latter group we investigated isoguanosine from croton seed and adenine-thiomethylpentoside from yeast. These compounds failed also to respond to deaminase in experiments with the crude enzyme—adenosine deaminase.

The pathways of nucleic acid degradation combine a series of enzymatic processes. From textbooks we learn that nucleotides are broken down by nucleotidase to nucleosides and phosphoric acid. Nucleosides are split by nucleosidase into base and carbohydrate. No statements are found concerning the fate of the carbohydrate (ribose). Recent experiments seem to indicate that extension of our knowledge is in the making. Klein and Kalckar found that phosphate is taken up in the process of nucleosidase splitting. Ribose-1-phosphate is formed in this process.

We found that this ester is only an intermediate in the sequence of degradations. It is rapidly converted to a stable phosphoric acid ester, probably ribose-5-phosphate. The rearrangement of phosphate from position 1 to position 5 resembles the change from Cori ester to Robison ester under the influence of phosphoglucomutase in hexose degradation.

It is difficult to isolate ribose-5-phosphate from the reaction mixture, since it undergoes further changes rapidly. The pentose disappears. We have succeeded in isolating a stable barium salt of phosphate ester, and are attempting to characterize it. It is similar to Robinson ester and gives a positive hexose in absorption experiments with a spectophotometer. Recent efforts have been concentrated on purifying this compound so that it may be identified. The discovery of this phenomenon leads us to hope that the riddle of ribose metabolism in the body will soon be solved.

## MARINE PELECYPOD SHELLS OF PORTO RICO AND MONA ISLAND

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A collection of marine shells was made in this area during 1945 and 1946. Fifty-four different species of Pelecypod shells have been identified from this collection. The identifications, locality records, and some notations on distribution and abundance are included. The identifications have been confirmed by Dr. Paul Bartsch of the National Museum.

## ON THE MECHANISM OF ALLOXAN DIABETES

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The specific diabetogenic action of mesoxalylurea is shared only by methylalloxan and possibly a few other closely related pyrimidines, and the unrelated 2-(p-acetylaminostyryl)-6-dimethylaminoquinoline methochloride. Most of the simple pyrimidines thus far studied are not diabetogenic. Diabetogenic does of alloxan cause pathologic changes in the kidneys, spleen, thyroid and anterior pituitary, and probably affect function of many other organs. Alloxan diabetes is effectively antagonized by prior treatment with certain agents incompatible with alloxan or by sulfhydryl compounds. Glucose will reduce susceptibility of fasted rats to alloxan, but only if given at a considerable interval (6 hours) before the alloxan. Ligature of the duct of Wirsung prevents alloxan diabetes. In the rat, the nucleotides of ribonucleic acid (Pentnucleotide N. N. R.) are prophylactic against the diabetogenic action, while thymectomy intensifies it. Preliminary results indicate that splenectory is not similarly potentiating, perhaps because hypertrophy of the thymus may occur after splenectomy. These considerations suggest that diabetogensis by alloxan is highly specific and not primarily a function of redox potential; that it is directly antagonized by reduction or other chemical change, and indirectly through blocking of receptors by related agents; that the pyrimidine moiety of nucleic acids may function in either of these ways; and that susceptibility to alloxan is conditioned by the state of nucleoprotein metabolism in the organism, and consequently is related to some extent with reticuloendothelial function.

## THE EFFECTS OF ANGIOTONIN ON SERUM POTASSIUM IN DOGS

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Epinephrine and other pressor substances are well known to cause a temporary increase in the serum potassium of cats and dogs. Since parenterally injected potassium salts cause an increase in blood pressure as well as other pharmacological actions characteristic of epinephrine (1), there is reason to postulate a close relationship between these two substances concerning their action on cellular function as has been suggested by Camp and Higgins although this has been questioned by some investigators. The pressor substance, angiotonin, was tested in unanesthetized and in nembutalized dogs for its effect on the serum potassium levels. Blood samples taken before and 1, 5, 15 and 30 minutes after injection of the drug showed changes ranging from a 38% increase up to a 30% decrease in either the 1- or 5-minute samples with no regularity of change being observed. All 15-minute samples in the anesthetized animals were below their respective control values, possibly due to the anesthetic, as this did not occur in the unanesthetized animals. Equi-pressor doses of epinephrine in similar experiments gave a consistent rise in serum potassium. This preliminary study (20 experiments on 7 animals) indicates that no regular change in serum potassium levels is elicited by angiotonin injected into dogs and casts some doubt on the relationship of potassium levels to the rise in blood pressure caused by such pressor agents.

Reference:
(1) W. J. R. Camp and J. H. Higgins—J. Pharmacol. and Exper. Therap. Vol. 57, p. 376, 1936.

## MICROCULTURE OF EUGLENA

ARTHUR L. SCHIPPER, A. and M. College, College Station

These cultures were prepared by putting a drop of a culture, containing Euglena, within a ring of vaseline and placing a coverglass upon the vaseline. Euglena were found on such slides, eight months after their preparation. Microcultures containing both Euglena and Amoeba were more vigorous than those containing no Amoeba.

# BOTANICAL EDUCATION IN SOUTHWESTERN COLLEGES AND UNIVERSITIES

VICTOR A. GREULACH, A. & M. College, College Station, Texas

Botanical education has three principal objectives: (A) the training of a new generation of botanists, (B) the provision of background or service courses for students majoring in related sciences such as zoology, agronomy, horticulture, geology, forestry, and pharmacy, and (C) the general or liberal education of students specializing in other fields. The present study is concerned with the first of these three aspects. In the course of a more extensive study of botanical education in American colleges and universities,[1] it became evident that there are definite regional inequalities in the education of botanists and that the position of the Southwest in this respect is interesting enough to warrant a separate report.

The contribution of colleges or regions to the education of botanists was based on the number of graduates in this field. Information concerning this was secured from two sources. First, information was secured as to where all botanists listed in the seventh edition of **American Men of Science** (1) received their bachelor's and doctor's degrees.[2] The completed list included 1939 botanists who took their bachelor's degrees at American (including Canadian colleges or universities and 1640 who have American doctor's degrees. Those who listed their specialties as plant physiology, plant pathology, plant genetics, paleobotany, or any similar recognized subdivision of botany instead of the more general term "botany" were also included. Those in related sciences such as bacteriology, agronomy, horticulture, forestry, and plant biochemistry were not included. Master's degrees were not tabulated, as it was considered that they would not add sufficient information to warrant the extra work. However, this may have been unfair to a few universities which are particularly strong at the master's level. That these lists provide an adequate sample is indicated by the fact that the membership of the Botanical Society of America was 1381 in 1944 (3), that 2014 botanists belong to the A.A.A.S. (2), and that 2079 are registered with the National Roster of Scientific and Specialized Personnel (1).

Second, information was secured as to the number of doctorates in botany granted by American universities between 1930 and 1945 inclusive (5, 6). This provides more recent and inclusive information than that secured from **American Men of Science,** although it covers a shorter period of time. This list did not include Canadian universities. No similar information in regard to bachelor's degrees was available.

The regions of the country employed in this study are those used by Odum and Moore (7) and considered by them to provide a greater degree of cultural and geographic homogeneity within each region than

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1. This study will be reported on elsewhere later.
2. The writer wishes to acknowledge his indebtedness to Miss Marion Brooks for performing this laborious task.

any of the other regional divisions in common use. Since these regions differ from those often used it may be well to list the states included in each one:

1. **Northwest.** Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, District of Columbia, and West Virginia.
2. **Middle States.** Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, and Missouri.
3. **Northwest.** North Dakota, South Dakota, Nebraska, Kansas, Montana, Idaho, Wyoming, Colorado and Utah.
4. **Far West.** California, Oregon, Washington, and Nevada.
5. **Southwest.** Oklahoma, Texas, New Mexico, and Arizona.
6. **Southeast.** Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, and Louisiana.

The statistical results of the study are presented in Table I, which is really three tables combined into one. Item A gives the figures on the bachelor's degrees of botanists listed in **American Men of Science,** Item B those on doctor's degrees from the same volume, and Item C the number of doctorates in botany awarded 1930-45.

The first column of the table gives the total number of schools in each region which could possibly be expected to produce graduates in botany. The A figure includes all regular colleges, universities, and teacher's colleges. The B and C figures include all universities giving the Ph. D. degree in the sciences. The second column lists the number of schools in each region with one or more graduates in botany and the third, those schools with over five graduates. The fourth column gives the total number of graduates. Since the population of the various regions differs so greatly some sort of per capita figure is needed for adequate comparisons. This is provided in the last two columns. The fifth column gives the number of graduates per each 10,000 students enrolled in the colleges of the region in 1930 and the sixth, the number of graduates per million population of the region in 1930. The 1930 enrollments were selected in preference to later figures because they come somewhat nearer to the time when most of the graduates were attending college and because they avoid the distorted enrollments which have existed since the beginning of the war. Note that the two per capita ratios are quite similar in most cases.

Examination of the table reveals the fact that the Southwest is far behind most other regions in the production of botanists, and considerably below the average for the country as a whole. While the Southeast is also low, it ranks somewhat higher than the Southwest. The Northwest ranks only slightly higher than those two regions on doctor's degrees, but leads the country in the per capita production of botanists at the undergraduate level. Note the leading position of the Middle States, except for this one factor, on both an absolute and per capita basis. While the Northeast is high in total degrees awarded, both it and the Far West are at about the average for the country as a whole on a per capita basis.

### TABLE I. REGIONAL DISTRIBUTION OF GRADUATES IN BOTANY*

| Region | Item | Total Schools in Region | Schools Repre-sented | Schools with over five Graduates | Number of Graduates | Graduates/ 10,000 College Enrollment (1930) | Graduates/ 1,000,000 Population (1930) |
|---|---|---|---|---|---|---|---|
| North-east | A | 283 | 84 | 23 | 501 | 14.7 | 13.0 |
| | B | 32 | 25 | 14 | 562 | 16.5 | 14.6 |
| | C | 32 | 23 | 14 | 443 | 13.0 | 11.5 |
| Middle States | A | 242 | 91 | 23 | 697 | 24.4 | 20.6 |
| | B | 20 | 15 | 13 | 805 | 28.2 | 23.8 |
| | C | 20 | 19 | 13 | 696 | 24.4 | 20.6 |
| North-west | A | 84 | 35 | 12 | 218 | 32.9 | 29.6 |
| | B | 5 | 4 | 1 | 36 | 5.4 | 4.9 |
| | C | 5 | 3 | 1 | 38 | 5.8 | 5.2 |
| Far West | A | 67 | 18 | 6 | 187 | 21.2 | 22.9 |
| | B | 8 | 8 | 6 | 146 | 16.5 | 17.7 |
| | C | 8 | 8 | 6 | 163 | 18.5 | 19.7 |
| South-west | A | 56 | 18 | 3 | 52 | 8.4 | 5.7 |
| | B | 4 | 3 | 1 | 11 | 1.8 | 1.2 |
| | C | 4 | 3 | 1 | 21 | 3.4 | 2.3 |
| South-east | A | 169 | 43 | 12 | 160 | 12.5 | 6.3 |
| | B | 9 | 7 | 4 | 38 | 2.9 | 1.5 |
| | C | 9 | 6 | 4 | 72 | 5.6 | 2.8 |
| Canada | A | 25 | 14 | 9 | 124 | 30.0 | 12.0 |
| | B | 7 | 6 | 2 | 42 | 10.2 | 4.0 |
| | C | ---- | ---- | ---- | ---- | ---- | ---- |
| TOTAL | A | 901 | 303 | 88 | 1939 | 19.1 | 14.6 |
| | B | 78 | 68 | 41 | 1640 | 16.2 | 12.3 |
| | C | 78 | 62 | 39 | 1433 | 14.8 | 11.7 |

*Key to Symbols:
- A. Number of botanists listed in AMERICAN MEN OF SCIENCE who secured their batchelor's degrees within the region.
- B. Number of botanists listed in AMERICAN MEN OF SCIENCE who secured their doctor's degrees within the region.
- C. Number of doctor's degrees in botany awarded within the region 1930-1945, as listed in AMERICAN COLLEGES AND UNIVERSITIES and DOCTORATE DISSERTATIONS ACCEPTED BY AMERICAN UNIVERSITIES.

TABLE IA. PER CENT OF SCHOOLS IN EACH REGION WHICH HAVE GRADUATED FIVE OR MORE BOTANISTS WHO ARE LISTED IN **AMERICAN MEN OF SCIENCE.**

| Region | Bachelors | Doctors |
|---|---|---|
| Northeast | 8.1 | 43.8 |
| Middle States | 9.5 | 65.0 |
| Northwest | 14.3 | 20.0 |
| Far West | 9.0 | 75.0 |
| Southwest | 5.4 | 25.0 |
| Southeast | 7.1 | 44.5 |
| United States | 9.6 | 50.0 |

Table Ia indicates that the Southwest is not greatly deficient in the number of schools graduating five or more botanists. One additional university at the graduate level and two additional at the undergraduate level would bring it up to the national average. The deficiency is due more to the smaller numbers of students taking botany in schools where it is offered.

The relative status of botanical education in the Southwest is also indicated in Table II. This table includes all colleges with ten or more graduates with bachelor's degrees in botany listed in AMERICAN MEN OF SCIENCE, all universities with more than five doctorate graduates listed in that volume, and all universities granting more than five doctorates in botany 1930-1945 inclusive. Notice that the University of Texas is the only Southwestern school included in any of the three lists of ranking schools. All Southwestern schools with graduates in botany represented in the complete lists are added for comparison.

One striking feature of the list of bachelor's degrees is the presence of a number of small and medium-sized liberal arts colleges, some of them having produced more graduates in botany than many of the larger universities. They include Wabash, Oberlin, Miami (Ohio), DePauw, Wellesley, Smith, Dartmouth, and Butler. Most of these colleges are in the Middle States and the rest are in the Northeast. Wabash, a men's college in Indiana with annual enrollment of less than 400, is perhaps the most outstanding. The superiority of these schools over many other similar colleges which have few or no graduates in botany can be traced in almost every case to the influence over a period of years of an unusually capable and stimulating teacher or teachers of botany.

The question arose as to whether the low production of botanists in the Southwest was characteristic of this science alone, or whether a similar situation existed in other sciences. To secure information on this point the number of doctor's degrees awarded between 1930 and 1939 inclusive in various sciences (6) was tabulated. This information is presented in Table III, along with the per cent of total degrees in each science for each region and the number of degrees in each region per 10,000 students.

## TABLE II. AMERICAN UNIVERSITIES AND COLLEGES RANKED AS TO THE NUMBER OF GRADUATES IN BOTANY

| A. Bachelors, Amer. Men of Sci. | | B. Doctors, Amer. Men of Sci. | | C. Doctors, 1930-1945* | |
|---|---|---|---|---|---|
| Wisconsin | 72 | Wisconsin | 192 | Wisconsin | 131 |
| California | 56 | Chicago | 176 | Chicago | 131 |
| Minnesota | 55 | Cornell | 174 | Cornell | 92 |
| Cornell | 48 | Harvard | 100 | Minnesota | 88 |
| Nebraska | 48 | Minnesota | 92 | California | 88 |
| Michigan | 41 | California | 84 | Harvard | 85 |
| Chicago | 40 | Columbia | 72 | Michigan | 65 |
| Mass. State | 35 | Michigan | 63 | Ohio State | 62 |
| Illinois | 34 | Iowa State | 52 | Columbia | 56 |
| Ohio State | 33 | Ohio State | 51 | Iowa State | 49 |
| Iowa State | 33 | Illinois | 50 | Yale | 43 |
| Harvard | 33 | Wash. U. | 41 | Illinois | 35 |
| Mich. State | 32 | Johns Hopkins | 34 | Pennsylvania | 35 |
| Missouri | 31 | Pennsylvania | 32 | Wash. U. | 33 |
| Wash. State | 30 | Maryland | 28 | Iowa | 30 |
| Penn. State | 28 | Nebraska | 28 | Nebraska | 29 |
| Wabash | 28 | Toronto | 28 | Virginia | 26 |
| Kansas State | 27 | Missouri | 27 | Maryland | 25 |
| Toronto | 27 | Yale | 25 | Stanford | 25 |
| Oregon State | 25 | Rutgers | 23 | Duke | 23 |
| Stanford | 25 | Stanford | 23 | Pittsburgh | 21 |
| Indiana | 23 | Iowa | 18 | Missouri | 20 |
| Oberlin | 23 | Pittsburgh | 16 | Catholic | 18 |
| Miami | 21 | Mich. State | 14 | U. of Wash. | 17 |
| Syracuse | 21 | Wash. State | 14 | Texas | 17 |
| Clemson | 20 | Virginia | 13 | Johns Hopkins | 14 |
| Columbia | 19 | Duke | 12 | North Car. | 12 |
| Pennsylvania | 18 | Indiana | 11 | Indiana | 11 |
| McGill | 18 | U. of Wash. | 11 | Cal. Tech | 11 |
| DePauw | 16 | Catholic | 9 | Rutgers | 10 |
| Ntah State | 16 | Penn. State | 9 | Michigan St. | 10 |
| U. of Washington | 16 | Texas | 9 | Purdue | 10 |
| Wellsley | 16 | McGill | 9 | Wash. State | 10 |
| Purdue | 15 | Radcliffe | 8 | Penn. State | 9 |
| Smith | 15 | Cal. Tech. | 7 | Syracuse | 9 |
| West Virginia | 15 | Purdue | 7 | L. S. U. | 8 |
| Dartmouth | 14 | Geo. Wash. | 7 | Oregon State | 8 |
| Texas | 14 | North Car. | 6 | Fordham | 7 |
| Maine | 13 | Syracuse | 6 | Radcliffe | 6 |
| Queens | 13 | | | | |
| S. Dak. State | 13 | | | | |
| Vermont | 13 | | | | |
| Idaho | 12 | | | | |
| Rutgers | 12 | | | | |
| Maryland | 12 | | | | |
| Miss. A&M | 12 | | | | |
| Saskatchwan | 11 | | | | |
| Butler | 10 | | | | |
| Geo. Washington | 10 | | | | |

| Additional Southwestern | | Additional Southwestern | | Additional Southwestern | |
|---|---|---|---|---|---|
| New Mexico | 6 | Arizona | 1 | Arizona | 2 |
| Oklahoma | 6 | Oklahoma | 1 | Oklahoma | 2 |
| Oklahoma A&M | 5 | | | | |
| Arizona | 3 | | | | |
| Texas A&M | 3 | | | | |
| Baylor | 2 | | | | |
| Oklahoma Baptists | 2 | | | | |
| St. Marys | 2 | | | | |
| T.S.T.C. | 2 | | | | |
| Our Lady of the Lake | 1 | | | | |
| N. M. College | 1 | | | | |
| Phillips | 1 | | | | |
| Southern Methodist | 1 | | | | |
| Southwestern | 1 | | | | |
| Texas Tech | 1 | | | | |

* Canadian Universities not included

## TABLE III. REGIONAL DISTRIBUTION OF DOCTORS DEGREES IN REPRESENTATIVE SCIENCES, 1930-1939*

| Region | Item | Chemistry | Physics | Geology | Botany | Zoology | Agriculture | Total |
|---|---|---|---|---|---|---|---|---|
| North-east | A | 1716 | 515 | 249 | 295 | 460 | 227 | 3462 |
| | B | 40.2 | 40.5 | 48.1 | 31.6 | 42.0 | 40.5 | 40.0 |
| | C | 50.5 | 15.2 | 7.3 | 8.7 | 13.5 | 6.7 | 101.9 |
| Middle States | A | 1904 | 466 | 176 | 469 | 416 | 294 | 3725 |
| | B | 44.6 | 36.7 | 34.0 | 50.2 | 38.0 | 52.5 | 43.2 |
| | C | 67.0 | 16.3 | 6.2 | 16.4 | 14.6 | 10.3 | 130.8 |
| North-west | A | 108 | 13 | 11 | 20 | 23 | 13 | 188 |
| | B | 2.5 | 1.1 | 2.1 | 2.2 | 2.1 | 2.3 | 2.2 |
| | C | 16.3 | 1.9 | 1.7 | 3.0 | 3.5 | 1.9 | 28.3 |
| Far West | A | 320 | 201 | 65 | 99 | 125 | 25 | 835 |
| | B | 7.5 | 15.8 | 12.5 | 10.6 | 11.4 | 4.4 | 9.7 |
| | C | 36.2 | 22.8 | 7.3 | 11.2 | 14.2 | 2.8 | 94.5 |
| South-west | A | 58 | 25 | 9 | 13 | 25 | 2 | 132 |
| | B | 1.4 | 2.0 | 1.8 | 1.4 | 2.4 | 0.3 | 1.5 |
| | C | 9.2 | 4.0 | 1.4 | 2.1 | 4.0 | 0.3 | 21.0 |
| South-east | A | 154 | 51 | 8 | 37 | 45 | 0 | 295 |
| | B | 3.7 | 4.0 | 1.5 | 4.0 | 4.1 | 0 | 3.4 |
| | C | 12.0 | 4.0 | 0.6 | 2.9 | 3.5 | 0 | 23.0 |
| United States | A | 4260 | 1271 | 518 | 933 | 1094 | 561 | 8637 |
| | B | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | C | 44.0 | 13.1 | 5.3 | 9.6 | 11.3 | 5.8 | 89.1 |

*Key to Symbols:
A. Number of Ph. D.'s awarded 1930-1939 inclusive.
B. Per cent of total degrees in that particular science.
C. Number of degrees per 10,000 college students enrolled in 1930.

Examination of this table indicates that the Southwest is low in the production, not only of botanists, but of graduates in all the sciences listed, both on a per capita basis and the per cent of degrees awarded in each science. The percentages for zoology and physics are somewhat higher than for the other sciences, and the percentage for agriculture much lower.

No effort is being made to explain the rather low status of the Southwest, and to a somewhat lesser degree the Southeast, in the education of botanists and other scientists. A number of possible explanations will probably occur to the reader. Whatever the causes, we should make every effort to locate and correct them, for it is quite evident that this region is not carrying its fair proportion of the education of our future scientists. This deficiency is particularly serious in such sciences as botany, zoology, and geology which in many of their aspects have a definitely local character.

Fortunately, there are some indications that the situation in the Southwest in regard to botanical education is improving. The University of Texas, which has been the leading university in the Southwest in botanical education, shows renewed promise. The University of Oklahoma Department of Plant Sciences has been growing and shows considerable promise. There is no reason why at least these two universities, if given an opportunity, should not develop botany departments comparable with any in the country. Other colleges which should be in a position to provide at least strong undergraduate and possibly graduate work in botany include Texas A. and M., Arizona, New Mexico, Oklahoma A. and M., Southern Methodist, Texas Tech, and perhaps others. If the establishment of outstanding graduate work in the field is not feasible, at least it should be possible to achieve a condition similar to that in the Northwest, where a high per capita production of botanists exists at one undergraduate level, even though the percentage of doctors is relatively low.

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## RESIN RESTORATIONS IN DENTISTRY AND MEDICINE

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In both dentistry and medicine the synthetic resinous plastic materials are used either in the form of an accessory type of equipment or as a direct restoration. Many prefabricated items are now standard items of stock and the list includes such equipment as plastic oxygen tents, mattress protectors, aprons, moldable splints, tongue depressors, stethoscope bells and ear tips, and many other items which are commonplace in the dentist's, physician's and surgeon's office or operating room. Most of these items have been accepted because of their lightweight, non-irritating qualities, non-chilling characteristics, resistance to tissue fluids, as well as their ability to be sterilized.

In contrast to the prefabricated structures there are appliances and restorations which are constructed by the technician to meet the needs of individual cases. Plastic and oral surgeons have need to construct such restorations as the obturator for cleft plates, resin splints, artificial ears and eyes, as well as other restorations for both hard and soft tissues. Recently the acrylic resins have been used for making skull plates and windows to be used following surgical operations on the brain. The dental prosthetist uses the acrylic and vinyl resins for all types of dental restorations including the complete denture, and to a more limited degree for inlay, crown and bridge structures where the fixed type of dental restoration is required.

Among the most popular of the prosthetic materials for dental and surgical restorations are the acrylic resins. These products are usually marketed as a methyl methacrylate powder and liquid which is to be mixed by the person who is designing or constructing the restoration. The processing, or "curing" as it is generally called, involves certain fundamental practices that must be carefully controlled if a satisfactory, stable restoration is to be produced. Among the most annoying problems in the processing of acrylic restorations is the control of porosity of the finished structure. Porosity in the structure may be due to: (1) improper consistency in the mass when it is packed into the mold, (2) insufficient resin to fill the mold completely, (3) low pressure on the mold during processing, and (4) rapid heating during the processing of the resin structure.

The method of heating and the rate of temperature rise are perhaps the most important factors in the control of porosity in the finished structure.

It is now generally believed that a temperature of 70°C. is satisfactory for the processing of acrylic resins used for denture purposes. A safe practice is to place the mold containing the resin mass directly into a constant temperature water bath held at 70°C. Allow the mold to remain for at least three to four hours at this temperature. Longer times apparently produce no harmful results, whereas, too short a processing time may be harmful by not converting all of the residual monomer to the polymer state.

It is possible and often times convenient to use the heat supplied by one or more infra-red light bulbs. This heat will process the acrylic resin equally as well as will a water bath. It is essential, however, that the same temperature relationships be maintained in this practice as when the constant temperature control of the water bath is employed. Measurements indicate that the same linear shrinkage of 0.3 to 0.4% occurs during processing, regardless of the method used.

Studies are in progress with the use of induction of dielectric heating as a method of supplying the heat. The preliminary results from this practice are essentially the same as with the infra-red or constant temperature water bath.

Summary:

1. Plastic molding compounds have found extensive application in both medicine and dentistry.

2. To avoid porosity and to control other properties in custom molded acrylic structures such as complete dentures, splints or skull plates it is essential to control the temperature of polymerization carefully, regardless of the source of heat.

3. Heat produced from an infra-red light source, or by induction heating of the mold, when properly controlled, will polymerize acrylic restorations as satisfactorily as a constant temperature water bath.

## PROPER TITLES, SUMMARIES AND ABSTRACTS IN BIOLOGICAL PAPERS

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The ordinary scientific writer works diligently with the text of his paper. He usually feels that if he gets his work published the job of making it public is done. Unfortunately, scientific journals reach only very few people. The titles alone have a much wider distribution, through compiled bibliographies on certain subjects, bibliographies in subsequent research and review papers, abstract journals and the cross-indices of many libraries. Therefore, it pays the scientific writer to give close attention to titles of research papers. An obscure or misleading title may prevent a paper being used by workers who would be deeply interested in it, if they knew of its existence. Many of us have had the experience of publishing a paper and finding afterwards a title we should have cited, or even more disturbing, we have had our own works overlooked. Bickerings over priority and self-righteous little notes pointing out that so and so found out such and such and published the results prior to the more recently reported "discovery" by someone else, are all too familiar. These matters indicate defects in the "scientific method" of disseminating knowledge.

Gudger (1924), the eminent bibliographer of fishes, has written a paper on titles of papers, which I read a few years ago. Several ideas expressed here were probably derived from him. They are not all original and any person who stops to think logically about the subject will arrive at the same general conclusions. Nevetheless, they will bear repetition and re-emphasis from time to time.

Most biologists are not bibliographers at heart. Whether this characteristic is good or bad is beside the point, if the scientific writer considers practically the problem of reaching the widest interested audience. It is much better to have titles too long than to have them too short, and thus obscure. Every important subject treated in a paper should be mentioned in the title. Newspapermen have a rule saying the first paragraph of a news story should say who, what, when, where and how. The title of a paper, with the author's name and that of the organization with which he works, should give briefly the who, what and where at the beginning of the paper. In certain ecological papers it is worthwhile at times to include 'when' in the title. Naturally, all of these points except 'who' are elaborated upon in the text of the paper. Here it may be noted that the name of the organization with which the scientist is connected is sometimes given as a footnote at the bottom of the first page or even appended to the end of the paper. This is a matter of editorial policy, but the placing of the name of the organization at the bottom of the first page or at the end of the article, is a useless separation of matters which should go together under the title.

Such titles as "The Fishes of Utopia" have been pre-empted by systematists and everyone understands it. This is one example of a short title which is fairly satisfactory. Other short titles are usually defective. An example of a poor, short title, very close to home and much regretted by the author, is my "Studies on Marine Fishes of Texas." This ecological study covered a variety of subjects including relative numbers of species, seasonal cycles and movements, relations of the fishes to salinity, relations to temperature, effects of sudden cold spells and life history notes. The somewhat lengthy, but only minimally sufficient subtitle never appeared. As it stands the title could mean most anything and explains very little. I have heard this work described as a faunistic and taxonomic paper by people who should know better, but who were doubtless confused by the title. Some of the topics and conclusions are of a general nature and would be as applicable to the Baltic Sea as to the Texas Coast, but probably no Finnish biologist will ever think of looking at it, if he sees only the title.

Titles which are misleading by being too inclusive, stand in another category. They cause scientists to waste time searching for material they do not contain. They are stated to be, for instance, on the osteology of the cat, whereas they concern only the skull; or are said to be on the anatomy of the cat, but are only concerned with the osteology. Gudger (**op. cit.**) has given some good examples.

Since this manuscript was first written a note on titles by Stevens (1946), appeared. He takes up nearly all categories of poor titles, giving examples, including those that are ambigous, too short and too long. However, he seems to be inclined to favor short titles, even going so far as to advocate dropping the word **bird** in a paper on bird migration. A reader of such a title alone would not know what group of animals the paper was concerned with, unless it were possible to guess from the journal name, and the paper would not appear under **bird** in indices. I have presented some of the arguments against this state of affairs, reiterating to some extent Gudger's (**op. cit.**) views. While disagreeing with that part of Steven's remarks, I am in accord with his argument for shortening titles by deletion of superfluous adjectives and articles.

Summaries and abstracts can be treated together. It appears that they are improving, at least in the biological field, probably due in part to the great service the editors of Biological Abstracts have done, not only in disseminating biological knowledge, but in setting the example for good abstracts. Nevertheless, we still see summaries such as this:

"1. The food habits of **Exus weyus** in the Jigsaw Mountains are discussed.
2. The breeding season and hibernation behavior were found to be correlated with temperature and length of daylight.
3. Etc."

Such summaries tell nothing that should not be told in the title and appropriate topic headings within the paper. If the title and topic headings are poor, a summary of this type barely supplies the deficiency by giving some idea of what the paper is about. Otherwise, it adds nothing, merely takes up space and the paper would be better without it. Such summaries give me the impression of being coy attempts of the authors to inveigle the reader into reading the whole paper. In any case a summary of this type fails, for interest is much more likely to be aroused if the reader is given some information to go on.

Summaries and abstracts should be brief statements of fact setting forth the findings presented in a paper. The above summary could be just as easily written, and infinitely more worthwile, as follows:

"1. **Exus weyus** in the Jigsaw Mountains lives chiefly on pine seed and juniper berries.
2. The breeding season begins when the daily maximum temperature reaches 22°C. Hibernation begins when the period of daylight drops below 9 hours.
3. Etc."

Stevens' (op. cit.) remarks on the unnecessary verbiage involved in articles and adjectives used applies to summaries and abstracts as well as to titles.

The output of scientific literature is increasing by leaps and bounds and it might be said that he who reads must run. In a journal such as SCIENCE, with a diversified array of papers and notes, I find that even the short papers, except for those which are essentially abstracts or summaries themselves, are more useful if they have summaries.

While keeping up with one's own specialty becomes more difficult, there has been a trend towards breaking down of the compartmentalization of the sciences, and their essential unity with neighboring fields becomes more apparent every day. While the scientist has a harder time than ever keeping up with his own field he is confronted more and more with relevant information from other branches of science, which he would like to know something about. If we may elaborate the old saw, it is becoming necessary to know more and more to understand less and less. This state of affairs means that the need for informative summaries is becoming more important than ever before, and further that summaries should be written with a new idea in mind. Some effort should be given to making the summary not only a short, factual statement of the results found or ideas set forth in a paper, but comprehensible to the general reader, who might not undertestand the techniques described or the terminology of the main paper.

## Summary

Titles have much wide distribution than papers themselves and failure to give a long, complete title may cause a paper to go unnoticed by workers who would be deeply interested in the contents. This entails loss to the author and the scientific world.

Summaries and abstracts should be short, factual statements of the conclusions, and not merely brief statements on what the work was about, which can better be given in the title and topic headings. Scientists more and more are finding information in fields outside of their specialty relevant to their work and authors should make some attempt to write summaries in terms comprehensible to general readers, whose specialties lie in other fields.

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# MOSQUITOES IN THE VICINITY OF NACOGDOCHES

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The purpose of this study was to find out more about the mosquitoes of the Nacogdoches area, to determine the species present, to estimate their relative abundance, and to study their breeding places. A total of seventy-one collections were made from February 19 to November 12, 1946. During this period approximately 5,000 mosquitoes were collected and identified. Mosquitoes of three tribes, six genera, and seventeen species were taken. Identifications wre checked by the Texas State Health Department.

The writer gratefully acknowledges his indebtedness to Dr. Roy H. Adams for his invaluable counsel and assistance throughout the study. Grateful acknowledgment is also made to Dr. George W. Cox, Texas State Health Officer, for the assistance his Department rendered in the study. The writer also acknowledges the assistance of others whose bulletins proved useful.

## Methods

The time spent collecting mosquitoes was utilized in larval collections. A white enamaled dipper was used in collecting larvae. All types of breeding waters were examined and, for the most part, ten dips were made in each habitat. Negative samplings were not recorded. Larvae from a particular habitat were given a collection number and field notes were made giving the number of dips taken, number of larvae obtained, date, locality, and habitat. Identifications were usualy made from fourth instar larvae. Most of the larvae were examined individually with a binocular dissecting microscope and the number of larvae of each species as well as the numbers of each larval instar stage in each collection were recorded.

Larvae were preserved in insect vials in a ten per cent formalin solution. Special attention was given to larval mounts and larval skin mounts. In making these mounts a modification of Berlese's chloral-gum medium, given by King, Bradley, and McNeel (1944), was used. In order to obtain adults both isolated and mass rearing of larvae were practiced. Emerged adults were allowed to harden for at least twenty-four hours before they were killed. Freshly killed adults were either mounted or placed in pill boxes.

For each collection the collection data and other pertinent information such as a record of larval vial collections, adult pill box specimens, adult mounts, adult display mounts, larval mounts, and larval skin mounts were recorded on an index card.

## Larval Habitats

There seems to be a definite tendency for mosquitoes to select certain types of water for larval development. Larvae of some species are very much restricted in habitats, while others are found developing in a variety of situations. **Psorophora** and several species of **Aedes** deposit their eggs in depressions in the ground, where they remain dormant until flooding by rain water permits their development. Females of other species lay their eggs directly on the surface of the water. At any rate, female mosquitoes do seem to exercise some selection in choosing places to oviposit.

During the course of this study larvae were collected from many habitats. These habitats have been grouped into the following types:

1. WOODLAND POOLS.—These were rather small temporary rain pools shaded by deciduous or coniferous trees. The floors of these pools were covered with a mat of decaying leaves.

2. TEMPORARY POOLS.—These were small, shallow rain pools of a temporary nature. Most of them were open grassy pools, although in a few cases no vegetation was present, and in two cases the pools were in complete shade under buildings with no vegetation.

3. IMPOUNDMENTS.—These might be considered small ponds of a semipermanent nature, for they dried up during the summer months. Grass and other low growing vegetation was present around the edges of these impoundments.

4. POOLED STREAMS.—These were small pools formed by the drying up of streams. Some were heavily shaded by trees, while others were open or lightly shaded by vegetation growing along the stream banks.

5. ORNAMENTAL POOLS.—These were small ornamental fish pools constructed of rock or concrete. Although they usually contained comparatively fresh water, at least a few decaying leaves were present in each pool. The investigator did not find larvae breeding in such pools where fish were present, and only on one occasion were larvae found when tadpoles were present.

6. MARSHES.—Marshy areas around lakes and ponds, as well as low swampy areas, were included under this heading. In every case the breeding areas were shaded by trees or by heavy aquatic vegetation. The water was shallow and often formed small pools.

7. ARTIFICIAL RECEPTACLES.—Bottles, jars, cans, and other receptacles were included in this classification.

8. PONDS AND LAKES.—In this type of habitat the larvae were taken from the shallow water around the edge of the shoreline. Aquatic plants and some dead vegetation were present in each case.

9. SEWAGE POOLS.—Such pools were caused by faulty sewer lines.

## Conclusions

The systematic position of the species collected and their relative abundance is given in Table I. **Culex quinquefasciatus, Anopheles punctipennis, Culex apicalis,** and **Psorophora confinnis,** respectively, were the most abundant species. The predominant **Aedes** of the area was **Aedes vexans. Anopheles punctipennis** was by far the most abundant **Anopheles.** The most common of the genus **Culex** was **Culex quinquefasciatus. Culex apicalis** was also very common. **Psorophora confinnis** was the most prevalent **Psorophora.**

TABLE I

List of Nacogdoches Mosquitoes, Their Systematic Position,* and Their Relative Abundance

| | |
|---|---|
| Tribe **ANOPHELINI** | |
| Genus **ANOPHELES** Meigen | |
| Subgenus **ANOPHELES** Meigen | |
| **Anopheles punctipennis** (Say) | Abundant |
| **Anopheles quadrimaculatus** Say | Rare |
| **Anopheles crucians** Wiedemann | Rare |
| Tribe **CULICINI** | |
| Genus **AEDES** Meigen | |
| Subgenus **OCHLEROTATUS** Lynch Arribalzaga | |
| **Aedes mitchellae** (Dyar) | Rare |
| **Aedes canadensis** (Theobald) | Fairly Rare |
| Subgenus **STEGOMYIA** Theobald | |
| **Aedes aegypti** (Linnaeus) | Fairly Rare |
| Subgenus **AEDIMORPHUS** Theobald | |
| **Aedes vexans** (Meigen) | Common |
| Genus **CULEX** Linnaeus | |
| Subgenus **NEOCULEX** Dyar | |
| **Culex apicalis** Adams | Abundant |
| Subgenus **CULEX** Linnaeus | |
| **Culex tarsalis** Coquillett | Fairly Rare |
| **Culex restuans** Theobald | Fairly Common |
| **Culex salinarius** Coquillett | Common |
| **Culex quinquefasciatus** Say | Abundant |
| Genus **CULISETA** Felt | |
| **Culiseta inornata** (Williston) | Fairly Common |
| Genus **PSOROPHORA** Robineau-Desvoidy | |
| Subgenus**PSOROPHORA** Robineau-Desvoidy | |
| **Psorophora ciliata** (Fabricius) | Fairly Rare |
| Subgenus **JANTHINOSOMA** Lynch Arribalzaga | |
| **Psorophora ferox** (Humboldt) | Rare |
| Subgenus **GRABHAMIA** Theobald | |
| **Psorophora confinnis** (Lynch Arribalzaga) | Abundant |
| Tribe **MEGARHININI** | |
| Genus **MEGARHINUS** Robineau- Desvoidy | |
| **Megarhinus septentrionalis** Dyar and Knab | Rare |

*Arranged according to Matheson (1944)

The majority of the species were collected from woodland and and temporary pools. Larvae of **Anopheles punctipennis, Culex apicalis,** and **Culex salinarius** were taken from a wide variety of habitats. The habitats of the remaining species were more restricted. The species with a wide range of larval habitats were found associated with several species, whereas those with more restricted habitats were, with two exceptions, found associated with fered species. The most common larval association was that of **Anopheyes punctipennis** and **Culex apicalis.** Larvae of both **Anopheles punctipennis** and **Culex apicalis** were found associated with several species. The second most common association was that of **Anopheles punctipennis** and **Psorophora confinnis.**

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## Q FEVER IN TEXAS

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### ABSTRACT

Q fever was recognized as a new disease in Australia some ten years ago. Subsequently the causative rickettsiae were found in ticks collected in Texas and elsewhere in the United States. Irons, Topping, Shepard, and Cox[1] summarized preliminary findings on an outbreak of illnesses at Amarillo, Texas, in March, 1946.

Two deaths with 55 cases occurred among 136 employees in three establishments handling livestock, particularly cattle. Cattle were believed to be the source of the human infection. The evidence for this was reviewed by Topping, Shepard, and Irons[2]. However, there was no evidence that the cattle were ill. These cattle were collected from

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[1] Outbreak of Q fever in the United States Pub. Health Dept., **61:** 784-785, 1946.

[2] Q Fever in the United States. I. Epidemiologic Studies of an Outbreak Among Stock Handlers and Slaughterhouse Workers J. A. M. A., **133:** 813-815, 1947.

various places and over-wintered in the wheat fields southwest of Amarillo, Texas. The exact manner of transmission could not be determined. There seemed to be a possibility that the infective agent had been present in the excreta from ticks, in the hair of a certain lot of cattle. However, no ticks were found at the time. It was also suggested that the infective agent might have been present in the discharges from the animals.

The Laboratories of the State Health Department have continued to perform tests on undiagnosed illnesses where physicians suspect the possibility of Q fever. In suspected Q fever the severity of the illness may vary from the mild influenza-like attack of short duration, to very severe illness with pneumonia. It remains to be determined how frequent the widespread Q fever is among those who work in or around livestock, particularly cattle.

## AIR-BORNE PLANT PATHOGENS

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In the last several decades the study of the microbiological population of the air has received considerable attention. This trend was best evidenced perhaps in 1942 when the American Association for the Advancement of Science conducted a symposium devoted to the study of microorganisms in the air. Subsequent publication of this symposium was issued under the title Aerobiology (1). Aerobiology is a newcomer to the literature of microbiology. It may be divided into extramural aerobiology and intramural aerobiology.

Extramural aerobiology has to be with insect populations, fungus spores, pollens, and all forms of life borne aloft and deposited locally or transported distances, and with some of the consequences of their distribution. Extramural aerobiology has to do also with methods of determining whether these are also allergens or pathogens or both.

Intramural aerobiology is concerned with the problems of contagion by air-borne infectious materials, and the behavior in the air of these and with means of providing barriers to the spread of infection. Recent studies in the development of biological warfare are concerned chiefly with the latter.

Perhaps the first recorded instance suggesting the possibility of dissemination of fungus spores by the air was made by Micheli in 1729 when he gave his report on the reproduction of fungi by spores (2). In this report he indicated that clouds of spores might be liberated into the air. As early as 1807, in demonstrating that bunt of wheat was caused by a fungus, Prevost mentioned the possibility of the spores being disseminated by wind at threshing time (3).

No subsequent major contribution in this field was made until 1923 when Stakman, in studying wheat rust (Puccinia graminis) epidemiology, exposed vaseline slides at various altitudes using the airplane for the first time for such purposes (4). He was successful not only in getting uredospores and teleutospores of wheat rust, but he also found other fungus spores including **Alternaria, Cladosporium,** and **Helminthosporium.** Blackley, as early as 1873, mentioned the presence of smut spores on pollen slides, and even reported severe allergic reactions to the inhalation of **Chaetomium** and **Penicillium** spores (5). He mentioned his findings in connection with a study of possible pollen allergy, whereas Stakman was investigating the air distribution of plant pathogens. Neither of these workers, it seems, considered the possibility that the presence of mold spores in the air might be concerned with inhalant allergy.

In 1924 and 1925 Van Leeuwen reported fungus allergy in as high as fifty percent of Dutch asthmatics (6, 7). These findings were more or less corroborated in America by Cooke (8) who called attention to house dust as a cause of bronchial asthma and Leopold and Leopold (9) who found that filtered air in a dust free room would receive the asthmatic symptoms of dust sensitive patients. Subsequently workers in Germany (10) and Spain (11) demonstrated that house dust sensitivity was often due to molds. Actually the first report of fungus allergy in North America was that of Cadham who described three cases of asthma from wheat rust (12).

Allergists, realizing that pollens were not the complete answer to their problems of respiratory allergic diseases as asthma and hay fever, became increasingly interested in the possibility of air-borne fungi as allergens. Cooperative efforts between physicians practicing allergy and mycologists and plant pathologists have contributed substantially to our present knowledge. It was necessary to determine what fungi were air-borne. To determine this surveys were undertaken. The results of these revealed that many of the fungi were plant pathogens.

During survey studies in this and other laboratories large numbers of fungi including fungus pathogens were identified on plates and slides. Since many fungus pathogens are obligate parasites, however, a possible considerable constituent of the air population is missed in plate studies. Many spores are probably overlooked on slides chiefly because of the difficulty in recognizing them. Physicians and others interested in air-borne allergens, however, are convinced that these are probably the causal agents involved in many of the undetermined cases of inhalant respiratory allergy.

It seems desirable therefore to design a series of studies which would add information to this particular problem. This paper is a report of a census of air-borne spores of certain plant pathogens common in the Austin area. Seven of these were selected including two species of smuts and rusts each and three powdery mildews: Johnson grass smut, **Sphacelotheca sorghi;** Bermuda grass smut, **Ustilago cynodontis;** Johnson grass rust, **Puccinia graminis,** var. **sorghi;** Dichondra rust, **Puccinia dichondrae;** powdery mildew on crape myrtle, **Microsphaera australiensis;** powdery mildew on **Evonymus, Microsphaera Alni;** powdery mildew on wild china, **Uncinula circinata.**

Johnson grass smut, Dichondra rust, powdery mildew on crape myrtle and powdery mildew on **Evonymus** appeared more or less simultaneously in early April; Bermuda grass smut appeared in early June; powdery mildew on wild china appeared in the first week in July and Johnson grass rust somewhat later in the same month. In the case of the smuts and rusts, the superficial symptoms of infection were diminished to the point that the host plants appeared to be normal following mid-July. These symptoms reappeared in the fall and have continued to the present time. The powdery mildews do not show this seasonal variation. They, too, have continued to the present time (December). It would seem that pathogens on their hosts are seasonal. It does not follow however that they are air-borne during the whole of the respective seasons.

Exposure slides were made over varying periods of time, the beginning dates somewhat coinciding with the beginning of the respective seasons: twelve weeks in the case of Johnson grass smut, Dichondra rust, powdery mildew on crape myrtle, and powdery mildew on Evonymus; six weeks for Bermuda grass smut; two weeks for powdery mildew on wild china. Johnson grass rust was checked for a week. The slides in each case were exposed daily.

A location was selected for each pathogen at which slides were exposed on sampling dates. These were on and near the campus and were representative of similar concentrations of infected plants throughout the city. These are referred to in the study as "sites."

The preparation of the slides for sampling the air followed somewhat the method employed in making so-called "pollen slides" used in determining air-borne pollen. Glycerine jelly, vaseline and other media are variously used. Glycerine jelly containing one percent methyl green was used in this experiment. Square centimeter areas were marked on the slides to serve for the "counts."

The slides were exposed at the respective sites for a period of twenty-four hours. Two slides were exposed at each sampling, one resting on the bottom of a petri dish, the other leaning against the side. The dish served both as a protection to the slides and for convenience in handling. These were placed at a distance of twenty-five feet from the infected plant, and, when possible, five to six feet above the ground. It was thought that spores collected under these conditions and in numbers would seem to indicate a possible allergen source.

In arriving at the count each slide was considered separately. The counts were ascertained in the following manner. The slides were read by traversing the square centimeter area ten times with the low power objective. The number of spores of the particular pathogen, other fungus spores, pollen grains, and other plant parts as leaf hairs each was recorded. The number of spores recorded in this way is the "count" and represents the approximate number of spores per cubic yard of air for twenty-four hours (13).

Slides of each of the pathogens studies were prepared as an aid in identifying the spores on the exposed slides. These are designated as "known slides" to distinguish them from the "exposed slides."

Some five-hundred slides have been examined as follows: Johnson grass smut 125; Bermuda grass smut 75; Johnson grass rust 15; Dichondra rust 125; powdery mildew on crape myrtle 125; powdery mildew on Evonymus 125; powdery mildew on wild china 50.

The number of spores observed on duplicate slides at a given sampling was somewhat consistent. Spore number in the smuts varied from fifteen to five hundred from sampling to sampling for Johnson grass and seventy-five to two hundred fifty for Bermuda grass; in the case of the rusts eight to fifteen for Johnson grass and not any for Dichondra. In contrast to smuts and rusts, particularly the smuts, numbers of powdery mildew spores were relatively small; one to three for crepe myrtle, one to three for Evonymus, and two to five for wild china.

The high numbers of smut spores is striking. These were observed as single spores and as clusters, at times the number in a cluster being estimated at five hundred.

The variation in the number is also striking. Selected from May eleventh to July seventeenth six counts of Johnson grass smut show a range including 75, 500, 500, 300, 100, and 15 respectively. A curve of these figures shows the peak in early June with high numbers continuing throughout the month and gradually falling to a low in mid-July. The incidence of this pathogen on its host followed somewhat this same picture, the smut season being at its peak in June. The season was somewhat arrested during the very hot and dry period following mid-July, reappearing in September.

The Bermuda grass smut picture followed somewhat that of Johnson grass smut except in the number of spores at any one sampling, and the variation in the number of spores during the season. This variation exhibited a range of seventy-five to two hundred fifty. The Bermuda grass smut season was observed to be somewhat shorter beginning in early June. This pathogen also reappeared on its host in September following its disappearance in mid-July.

Johnson grass rust was observed in the uredospore stage. Spore counts were made at the beginning of the season in July. These varied from eight to fifteen. The rust continued more or less consistently into the fall.

Dichondra rust presented an enigma. Although symptoms were obvious on the host and known slides yielded this pathogen in the teleutospore stage, Dichondra rust spores were never observed on the exposure slides. Results were negative even whn the slids were exposed directly beneath the infected leaves. However one hundred twenty-five slides were examined over a period of twelve weeks, which was coincident with its appearance on the host. This rust also reappeared in the fall.

The powdery mildews were observed in the conidiospore stage. Since ascocarps are produced later in the season these were entirely absent. Because of their size these are probably not carried extensively by the wind. Although asci and ascospores have been reported.

The conidiospores appeared mostly as single spores except on one slide each of powdery mildew on Evonymus and powdery mildew on wild china where a cluster of nine was observed.

The count yielded one to three for those from crape myrtle and Evonymus and two to five from wild china. Although the numbers are relatively small, powdery mildew spore counts were consistent and would seem to represent a fair picture of air dissemination, since a large number of slides was examined for each pathogen (125, 125, 50 respectively).

Spore sizes were noted for each pathogen. The smut spores were mostly globose, those of Johnson grass from 7.3 to 8.2 microns in diameter, those of Bermuda grass smut from 7.5 to 8.7 microns. The rust spores showed greater variation: uredospores of Johnson grass from 10.3 to 15.1 x 21.1 to 27.3; Dichondra teleutospores 26.8 to 29.2 x 17.8 to 18.0. The large rectangular conidiospores of the powdery mildews vary for the different species, but the size is fairly consistent within a species: on crape myrtle 35.5 x 9.3, on Evonymus 29.0 x 18.7, on wild china 38.2 x 12.3 microns.

Whereas smut spores were often found on slides exposed at sites for other pathogens, rust and powdery mildew spores were not found at other sites.

All the slides exposed for pathogens yielded spores of other fungi including **Alternaria, Helminthosporium, Spondylocladium** and other well known air forms. A number of spores were not identified. **Alternaria** was found on practically every slide exposed. It was particularly interesting that many times the spores appeared in chains which is characteristic of this mold in culture.

This preliminary study has revealed the following facts:

1. Spores of six of the seven pathogens investigated are air-borne at least within local areas.

2. These are seasonal rather than occasional and are correlated with host symptoms.

3. Spore numbers are high, or consistent, or both. It is true that smut spores are generally smaller than those of rusts or powdery mildews. However in this case it would seem that the numbers carried are not a reflection of the size of the spore, but rather an index to the amount of infected material and spore number on the host. For example, a smutted Johnson grass head would yield a larger number of spores for air dissemination than a badly mildewed wild china leaf.

4. Presence in the air of spores of plant pathogens is an index to infected host material. It does not follow however that infected host material is necessarily a source of air-borne spores. Of this Dichondra is an example. Appearing in April the season of this pathogen follows

that of Johnson grass smut, but in no case, even when slides were placed directly beneath the plant, were spores obtained on exposed slides.

Thus, when it can be established that spores of plant pathogens are air-borne, and that they occur consistently during seasons of host symptoms, and that many of them occur in high numbers, these must be recognized as constituents of the air population; and, as such, cannot be overlooked as possible allergens in inhalant respiratory diseases, as asthma and hay fever.

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## OBSERVATIONS OF CELLS FROM ASCITIC FLUID CULTURED IN VITRO * **

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In neoplastic peritonitis there is usually an abundance of both normal and malignant cells within the peritoneal cavity. These cells are easily obtained by paracentesis and centrifugation. For tissue culture studies, strict aseptic technique is required.

Hanging drop cultures and roller tube cultures (c.f. Gey, 1933) were prepared using a suspension of the cells obtained from the ascitic fluid. Heparinized rooster plasma and chick embryonic extract were used as nutritive media.

It is obvious that when studying cells taken from patients with various types of neoplastic peritonitis one will see a great multitude of different types of cells, which as yet cannot be definitely classified. There are usually many non-malignant inflammatory cells present which are easily recognized as lymphocytes, polymorphonuclear leukocytes, monocytes, macrophages, and the mesothelial cells of the peritoneal wall. The transformations of these cells in tissue culture are described in Downey's Handbook of Hematology (1938) in the chapter written by Bloom. However, frequently normal cells in tissue culture will closely resemble malignant types, especially when it is necessary to study individual cells.

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* Later published in extenso in Texas Rep. on Biol. and Med., 5: 92-111. 1947.

** Aided by a grant from J. B. Roerig and Company.

The first patient observed had the clinical diagnosis of scirrhous carcinoma of the stomach. When studied in vitro the cells found were of inflammatory types and these transformed into cells very closely resembling large fibroblasts. A great many showed multinucleation with as many as four nuclei being present. Occassionally large giant cells with 10 to 20 densely staining nuclei were found. By 216 hours of culture a foamy appearance was noted in the cytoplasm and some pyknosis was seen which was taken as evidence of disintegration.

A second patient was studied, this one with a clinical diagnosis of cirrhosis of the liver. The appearance of the cultures from beginning to end was the same as the first patient, tentatively confirming the impression that the first patient presented only non-malignant elements.

However, the third patient studied presented a picture that could not in any way be taken as normal. This patient had a clinical diagnosis of pseudomucinous systadenoma of the ovary with peritoneal metastases. Initially the cultures did not show a suspension of free cells, but large and small aggregations instead. These had a definite cellular architecture and represented the broken ends of papillary structures. The solid bits of tissue gradually transformed into definite uni- and multilocular cysts, containing a fluid having the appearance of pseudomucin. The cysts eventually spread out into large epithelial sheets. Few mitotic figures were seen. The tissue definitely displayed features characteristic of glandular tissue.

The fourth patient came to us with a diagnosis of adenocarcinoma of the ovary with peritoneal metastases. Initially clumps of cells were seen having the appearance of clumps previously described by Coman (1943) and Quensel (1928). The clumps were in the form of definitely organized plaques. These plaques also formed cysts containing a clear fluid, and were surrounded by a zone of liquification, suggesting a high rate of proteolysis. Epithelial sheet outgrowth was not noted. The cultures weer definitely epithelial and characteristic of glandular tissue. Mitotic figures were rare.

It was concluded from this small study that malignant tissue elements within the peritoneal cavity could be easily cultured in vitro, and in some cases these elements could readily be differentiated from normal cells. We would like to point out that this method of study, with further investigation, could be a very valuable diagnostic aid since it not only affords study of the cellular appearance, but also the rate of growth, differentiation, and proteolytic activity. Obviously these latter features are very important, especially in the diagnosis of obscure and border-line neoplasms. Aside from the possibility of aid in diagnosis, this method of study affords a very nice instrument for experimental investigation of neoplastic elements in the living and fixed states.

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# SECTION III: THE SOCIAL SCIENCES

A SURVEY OF ECTOPARASITES AMONG RATS IN GALVESTON AND A SURVEY OF TYPHUS. R. W. STRANDTMANN AND DOROTHY EBEN, Medical Branch University of Texas, Galveston. No abstract received.

GROWTH OF SUMAC SORGHUM IN RESPONSE TO ADDITIONS OF MANURE ON DALHART FINE SANDY LOAM. ARTHUR W. YOUNG. Texas Technological College, Lubbock, Texas. No abstract received.

THE THIAMINE AND RIBOFLAVIN RESERVES OF COLLEGE WOMEN AS SHOWN BY FASTINO-LEVEN EXCRETION TEST. FLORENCE I. SCOULAR, DORIS CHAFFIN, OPHELIA BEARD, North Texas State Teachers College. No abstract received.

## THE REHABILITATION OF THE DISABLED VETERAN

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Federal legislation providing rehabilitation for disabled veterans has placed a tremendous responsibility upon educational institutions, business organizations and the Veterans Administration that requires complete team-work for the job to be accomplished. It is the primary aim of the veterans of this war to provide security for themselves and their families, and it is also very important that these veterans have an opportunity to find their places in the economic and social order. For many of these veterans, the adjustment necessary to accomplish this objective was an easy process. With minor adjustments they were —and are—able to return to their homes and find their normal places in the work-a-day world. Unfortunately, however, this is not true for a great many other veterans; this applies particularly to those veterans who are now disabled and cannot pursue their former occupations due to their disabilities. It also applies to those veterans who, due to their disabilities, are now unable to pursue an occupation that had been contemplated prior to their service in the armed forces. A large segment of this group find it extremely difficult to do effective planning for their future because of their disabilities. The fabric of their lives has been ripped apart and now must be put back together, piece by piece.

This problem presents a challenge to every one of us. It is our direct responsibility to provide an opportunity for these veterans to become an asset to the social order rather than a liability; to become a tax payer rather than a tax consumer; to become a useful citizen rather than a public charge. It is readily apparent that it is our responsibility to assist these veterans in effecting such adjustments as may be necessary in order that they may make their contribution to our normal social and economic process.

To meet the needs of this situation, in March, 1943, the 78th Congress passed a law, now widely known as Public Law 16, and by it set the legislative process in motion to effect the rehabilitation of the disabled veteran. This law and its amendments provide that any veteran who has been awarded a pensionable degree of disability is eligible for vocational rehabilitation training provided the fact is established that his disability constitutes a need for such rehabilitation. Not every veteran who is disabled is eligible for rehabilitation training. Let us consider a veteran who held a Bachelor's Degree and was a school teacher prior to service. During his service in the armed forces, he sustained the loss of his left hand, amputated just above the wrist. This disability will in no way preclude his continuance in his pre-war occupation, and consequently would not constitute a need for rehabilitation training. The benefits as provided under this law set forth a training period not to exceed four years, or as much less time as is necessary to complete the rehabilitation of the veteran. In exceptional cases, the period of training may even exceed four years. The implications of this legislation are far-reaching in their scope. At no time in history has such a rehabilitation program been attempted; it is of such magnitude that it leaves no community in the land untouched and it is of such a nature that it requires the cooperation of all agencies and organizations—Federal, State and local.

The Veterans Administration Rehabilitation Service is specifically charged with the responsibility of administering the laws pertaining to the rehabilitation of veterans of World War II. This service includes four divisions:

1. The Registration and Research Division which acts as an agency to determine eligibility, performs the necessary registration of veterans who apply for benefits, and initiates studies, surveys and reports concerning present and future needs for training in the various occupational fields.

2. The Training Facilities Division which is responsible for developing adequate training facilities in schools, colleges, universities and private businesses.

3. The Advisement and Guidance Division which is responsible for counseling and advising the veteran concerning his future employment objective.

4. The Education and Training Division which is responsible for supervising the training of the disabled veteran and placing him in employment.

In planning for the rehabilitation of the disabled veteran, it became readily apparent that no existing agency was prepared to render effective service on a National scale. Such activity in the past has been performed on State and local basis rather than being National in its scope. Although a number of educational institutions provided excellent counseling and guidance services for their students, there had been no move to coordinate and standardize such activities. However, schools and colleges had done more work along this line than any other agency in the Nation and thus were in a better position to render this valuable service in the rehabilitation program. They provided a source for trained personnel, and they provided the logical location for counseling and guidance centers for the purpose of rendering service to the disabled veteran. On the faculties of colleges were outstanding people: men and women with a knowledge in the fundamental fields of psychology, business and industrial problems, labor problems, labor market analysis, tests and measurements, vocational guidance, mental hygiene and clinical psychology. In view of this reservoir of experienced and well qualified personnel, the Federal Government called upon these various schools and colleges to assist the Veterans Administration in the tremendous task of counseling with the veterans regarding the selection of their vocational objectives. The manner in which universities and colleges all over America responded to this call was extremely gratifying. A plan was then formulated whereby contracts would be negotiated between the Veterans Administration and the educational institution utilizing the technical and professional counseling services available in those institutions and this is the basis upon which we are now so successfully operating.

There are now 32 Guidance Centers in this Branch Office Area alone, comprising the states of Texas, Louisiana and Mississippi, and throughout the Nation there are over 300 such Guidance Centers. The types of service rendered by the instiutions vary in accordance with the counseling facilities available. Some colleges furnish psychometric and testing services only while others furnish complete counseling services including interviewing, testing, vocational and education counseling and personal adjustment counseling. The college furnishes its own personnel and is paid by the Veterans Administration for each service on a contract basis. The Veterans Administration furnishes a Vocational Adviser and a Training Officer in each Guidance Center in order to coordinate and supervise the program. Counselors employed by the college are called Vocational Appraisers in order to distinguish them from the Vocational Advisers employed by the Veterans Administration. The present operation of a Guidance Center is an outstanding example of the team-work so necessary to effect the rehabilitation of our returning servicemen. While each Guidance Center has a chief, who is an employee of the Veterans Administration, for the purpose of coordinating and supervising the activities, he cannot render effective service without the full cooperation and assistance of the institutional personnel.

Let us examine the procedure: When a veteran is discharged from the service, his records—including his medical records and his service history—are sent to the Regional Office having jurisdiction over the region in which he resides. If this man executes a request for rehabilitation, it reaches the Regional Office, Advisement and Guidance Section, where his file is immediately brought forward and reviewed. He is then given a date to report for advisement service to the Guidance Center nearest his home and his expenses are paid from the time he leaves his home until he returns. The fact that a veteran is requested to report for counseling services to a Guidance Center located at a school or college does not in any way imply that he will attend this college in pursuing his employment objective. A veteran may be counseled at Texas University and do all of his college work at Texas College of Arts and Industries, or he may be counseled at any Guidance Center and take no college work at all but take his training on the job. In most instances it has been found that the veteran desires to take his training at an institution or establishment near his home, but in any event the location of the Veterans Administration Guidance Center at which he receives counseling will in no way limit or influence the selection of his place of training. During the advisement process, every effort is made to determine the veteran's interests, abilities and aptitudes; this is done by careful interview and by the use of psychological tests. The veteran's disability is considered at all times in order to be sure that he does not select an employment objective that will aggravate his disability. The indirect or client-centered technique of counseling is employed throughout the interview and the ultimate selection of the objective remains with the veteran. A skilled counselor conducts the interview in such a way that the veteran will see the advantage in selecting an employment objective for which he is best suited. After the interview has been completed and his employment objective has been selected, the veteran is then placed in training and further contacts that he has with the Veterans Administration are made through a Training Officer. The Training Officer visits the veteran at his place of training at least once each month for the purpose of rendering any assistance that he may be able to give the veteran. He is particularly concerned with the progress of the veteran and with the effect his disability has on his progress and his general adjustment.

Now our discussion thus far has covered the general procedure for the rehabilitation of the disabled veteran. The technique for the seriously disabled veteran varies somewhat from the procedure used with a veteran who is not so seriously disabled. In the case of the seriously disabled veteran, the rehabilitation procedure begins during his period of hospitalization. When the medical authorities have determined that his physical condition is such that he is ready to discuss vocational training, he is referred to a Vocational Adviser, located at the hospital, for the purpose of counsel and guidance concerning his future occupational plans. A psychometrist, who is a member of the Adviser's staff at the hospital, gives the veteran such tests as may be necessary for the purpose of discovering his interests, aptitudes and abilities, and makes appropriate recommendations to the Vocational Adviser. With the seriously disabled veteran this process may cover a period of several weeks, depending upon the veteran's physical condition. After counsel regarding his vocational plans, and after having decided upon an employment objective, the veteran is referred to the Hospital Retraining Service where he engages in the work or in a similar activity to that which he will eventually pursue upon return to his home community. Here, also, the entire counseling procedure is based upon the client-centered or indirect technique. This means that the atmosphere during the advisement is such that the veteran feels free at all times to express himself, and in the ultimate choice of the objective it is the veteran who makes the selection after having all factors—tests, past work experience, environmental and social background—thoroughly explained by the Adviser. In the case of the most seriously disabled in the hospitals, a Special Medical Rehabilitation Board is set up, composed of the Chief, Physical Medicine, as chairman; the Chief of Retraining; the Ward Physician; the Occupational Therapist; the Physical Therapist; the Social Worker; the Chaplain; the Vocational Adviser, and the Training Officer. The purpose of this board is to pool the knowledge of each specialist so that no point will be overlooked in the vocational rehabilitation plan of the veteran. Each specialist contributes in his field to the ultimate end that the objective selected will be suitable to the veteran; that it will be one which the veteran can do and enjoy; that it will be one which will not over tax either physical or emotional strength, and that it will be one in which he can become an integral part of the social and economic order leading to his eventual complete vocational rehabilitation. The process of rehabilitation of the individual must be a process involving the rehabilitation of the whole. It is a process that involves physical, mental and emotional rehabilitation simultaneously, rather than affecting rehabilitation in each category, separate and apart from the others. The physical and mental activities of the disabled veteran in the hospital actually are performed for the purpose of therapeutic treatment, however, under the present conception of medical rehabilitation, it is felt that such therapy increases in value when it is meaningful or functional to the patient. Consequently, it has been found to be to the advantage of the disabled veteran to direct his therapeutic treatment toward some gainful purpose and therefore early advisement activity is instituted in hospitals to accomplish this end. Upon his discharge from the hospital, the complete records of the veteran are transferred to the Veterans Administration Regional Office having jurisdiction over the region in which he resides, and there the rehabilitation process is continued.

Special Rehabilitation Procedures have been established in each Regional Office for the purpose of continuing with all veterans referred from the hospital. Here, as in the hospital, a board of specialists has been created for the purpose of giving careful consideration to the disabled veteran, however, this board is concerned only with vocational rehabilitation rather than medical rehabilitation. The membership of this board is made up of a Vocational Adviser, Training Officer, Medical Consultant, Social Worker, Consulting Psychologist and Psychiatrist, with Vocational Adviser and Training Officer Specialists as consulting members in the following categories:

1. Blinded
2. Deafened and hard of hearing
3. Cardiovascular
4. Tuberculous
5. Neuropsychiatric
6. Orthopedic

Special courses have been instituted to provide specialized training in the rehabilitation of the veteran in these disabilities. As in the hospital procedure, each member of this board contributes in his specialty so that all factors will be considered in formulating the rehabilitation program of the disabled veteran. After all factors have been considered by the board, the veteran is entered into training by the Training Officer Specialist and the Training Officer provides supervision throughout his training period. During this time the Training Officer becomes thoroughly familiar with each problem the veteran has; he virtually lives with the veteran, constantly encouraging and coaching him to achieve the goal he is attempting to reach.

In many instances, work tolerance has been indicated providing that the disabled veteran spend only a limited number of hours in training each day beginning with, we shall say, four hours and building up until he can do a full day's work. Throughout his supervision, the Training Officer is alert to detect any evidence of breakdown and evidence of nervous tension or emotional strain that may have any effect upon the veteran's training progress. If such conditions are noted, remedial measures are provided. Specialists are necessary in this field in order that the minimal signs will be recognized before it is too late to take remedial action.

It is not the policy of the Veterans Administration to drop a disabled veteran the minute he is declared rehabilitated. The responsibility of securing a job for this veteran is accepted as evidence of the fact that a thorough job of rehabilitation has been accomplished. It is felt that this is a definite obligation to the veteran, and the law authorizes payment for subsistence for two months after his training is completed. In selecting the final place of employment for the veteran extreme care is exercised, taking into consideration the veteran's disability and the effect his work will have upon his disability. He must be placed in a work environment that will not aggravate his condition and one in which he will receive the proper reception and understanding by his employer.

In order to be more concrete in the discussion of the rehabilitation of the disabled veteran, let us examine a few typical cases that illustrate the actual process involved and the effect on the individual: Let's take the case of a veteran whom we shall call Jack. Jack was born in Gertrude, Washington, January 31, 1920; attended public school there, completing the fifth grade. He was inducted into military service November 3, 1941, served with the 413th Infantry in the American and Rhineland military zones as a rifleman. He was a Pfc in the service, performing all the duties required of a combat infantryman. His decorations include the American Defense Ribbon, Good Conduct Ribbon, Victory Ribbon, American Theatre Ribbon, Purple Heart with Oak Leaf Cluster and Combat Infantry Badge. He was wounded on June 4, 1944, in combat in the Rhineland Zone, receiving multiple gunshot wounds in right and left legs. The condition of his right leg necessitated amputation at his right thigh. Jack was discharged from the service May 2, 1946. At the time of his discharge he stated that he did not desire to enter training because he was "not able." He apparently felt he was disabled to such degree that there was no trade to which he could adjust himself, however, he was subsequently contacted and the program explained to him and a complete battery of tests administered. A summary of the findings indicated his disability required some type of bench work; his vocational interests were in the field of mechanical work, and his low mental capacity and manual dexterity levels contraindicated any work involving close tolerance operation. The following employment objectives were considered: Leather Worker, Floral Designer, Watch Repairman, Gunsmith. It should be remembered that this veteran's disability precluded any type of strenuous work and should be one in which he could perform his duties while sitting; his mental ability was limited, as well as his academic training, and dexterity tests prohibited rapid manipulation. The final employment objective selected by the veteran was Gun and Fishing Tackle Repairman. It was estimated that it would require 30 months of training for the veteran to become proficient and able to maintain steady employment in this objective. He entered training July 22, 1946, in a gun and locksmith shop in a Central Texas town. His progress since that time has been extremely gratifying; he is well adjusted to his training situation, and indications are that his training will continue to a satisfactory conclusion and that he will be employed at his place of training upon completion of his training period.

Another example is that of a veteran whom we shall call John, who presents an outstanding example of fortitude and determination to overcome a disability imposed by war injuries. When he was inducted into the Army on March 2, 1943, John could not present a background of academic achievement. Forced to leave school in the eighth grade, he had worked as a telegraph messenger and as a light-truck driver. At the classification center, he was assigned to the Infantry. Aptitude and alertness caused him to be selected as Automatic Rifleman, and as such he was sent to the European Theatre of operation. At 2:20 on the afternoon of November 13, 1944 on the French Coast, John was caught in cross-fire of German small arms and shrapnel bursts. The 13th had been his unlucky day, for medical records show that the next morning at 9:20 it was necessary to amputate his left leg three inches above the knee-joint due to a gunshot wound in which severe artery and vein damage had been sustained. His right arm had to be dissected for removal of foreign particles. He was then returned to the States for further treatment in an Army hospital. It took a long time to get his stump healed and his arm properly coordinated, but he stayed with the hospital program to the last. He was subsequently discharged and made application for vocational rehabilitation. At a Guidance Center where John was advised, his interests and aptitudes indicated a high possibility of success as a Watch Repairman and this was the objective that he selected. He entered training January 21, 1946, and his record of accomplishment has been outstanding. His instructors have commended his work and he ranks among the highest in the class. Next month John will have completed the 12-months course in 11 months, and he already has a number of jobs waiting for him.

The summaries cited indicate the actual procedure involved in the rehabilitation process. It is obvious that this is a powerful program, gaining momentum daily. It is far reaching in its scope, both National and local, and delves so deeply into the lives of our citizens that the implication will be felt in the smallest community in the land. Those rehabilitated under this program will be the fathers of the next generation, and the ultimate success or failure of the program will depend upon the number of people who have been rehabilitated.

Responsibility exists in this program not only in assisting in individual adjustments, but in providing facilities for training of the disabled veteran. Judged from the humanitarian viewpoint alone, it is a definite responsibility to provide places of training—institutional and on-the-job—for the disabled veteran to receive his training. A realistic approach indicates that the disabled veteran is not necessarily disabled in the work involved in his particular objective. These men realize that they must excel in one field and must be able to do a job in that field better than anyone else. It is a well known fact that no one job requires all the faculties of an individual, and in the event a disabled veteran applies his remaining faculties to a job that requires only such activities that he is able to give, he is not handicapped for this job and as a result he will give more return on an investment than a non-disabled veteran.

At the present time there are 15,541 disabled veterans in training in this area. Of this number, 9,226 are in training in schools and colleges, and 6,315 are in training on-the-job. Two months ago the number in training in this Branch Area was 9,734. It is evident that the number is increasing and there is still much to be done. Applications are coming in at the rate of 3,000 per month and many of these veterans constitute the most seriously disabled, inasmuch as many of them are just being released from the hospital. It will take our combined efforts—private business, the schools, colleges, community and Federal organizations—for many years to come in order to effect the rehabilitation of the disabled veteran.

# THE USE OF PSYCHOMETRICS IN THE ADVISEMENT AND TRAINING OF VETERANS

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The advisement of any individual with respect to the type of training he should enter must be based on an objective appraisal of such important factors as interests, general and specific aptitudes, academic background, special skills, and such personal factors as may influence or affect his success or failure while in training or on the job. The various types of psychological, interest, aptitude and achievement measuring devices, therefore, are perhaps the most essential tools of the counselor. They make possible comparisons of the counselee with others to whom the same test has been given, and, when used with such other data as educational background, work experience, employment and military records, they will enable the counselor to obtain a more complete picture of the claimant's personal assets and limitations.

The place of psychometrics in the advisement and training of veterans is well recognized. At most of the guidance centers tests constitute one of the most important instruments used in the appraisal of the claimant's occupational possibilities. Veterans who qualify under Public Law 346 as well as those who qualify under Public Law 16 may avail themselves of the testing services provided by the Veterans Administration. This applies to those who seek on the job training as well as to those who desire training on the secondary school or college levels.

Since the scope of this discussion must be greatly limited, no effort will be made to list and evaluate the various types of tests that are in general use. No references will be made to the different types of personality scales and their place in an advisement program. Counseling with respect to on the job training or training in non-collegiate institutions will be mentioned very briefly. The major emphasis will be placed on psychometrics as aids (1) in advising veterans with respect to admission to college, (2) in assisting veterans attending college in their vocational or professional adjustment, and (3) in determining advanced standing or college credit for certain types of training while in military service.

**Psychometrics in Advisement With Reference to Entering College:** Counselors are often confronted with the responsibility of advising veterans relative to admission to college or university. Many veterans had their preparatory training interrupted by military service; others left high school before they were graduated; still others, even though they are high school graduates, are questionable college material either because they present a pattern of preparatory subjects which ordinarily does not qualify them for admission or because their scholastic records are of a very low or inferior quality.

The Texas Association of Colleges has adopted the policy which permits any Texas institution to admit on the basis of individual approval a veteran who is eighteen years or older even though the formal admission requirements have not been met. Institutions have already discovered that many of these applicants are better college risks than some others who conform to the required admission pattern.

Counselors confronted with the problem of advising veterans whose preparatory background gives rise to doubts as to their ability to succeed in college work may be aided greatly by the proper use of standardized general mental ability and achievement tests. Numerous studies of the predictive value of such measuring devices have pointed definitely to their usefulness. The important role which they may play in an advisement program will be shown by describing the practices in one institution.

About two years ago, Southern Methodist University began to be beseiged with applications from veterans who had not fulfilled the prescribed entrance requirements. The problem of advisement became more acute as the number of applicants for admission increased and as the need for selective admission grew. The University was not only interested in the selection of reasonably good college prospects but also in helping veterans determine whether or not a college career seemed feasible. Veterans whose admission status was in question, therefore, were required to take a battery of entrance examinations. This batter included tests of general mental ability and the **Iowa High School Content Examination.**

This policy enabled the institution to make a more intelligent selection of those who were to be admitted and to offer some direction to those who failed to qualify. Applicants who had taken the General Educational Development Tests while in the service or at one of the Veterans Administration guidance centers and who furnished an official transcript of their scores were not required to take additional examinations.

Numerous excellent college prospects were discovered. Some individuals with only two or three years of high school credit ranked among the upper 25% of college freshmen, both in general mental ability and in scholastic achievement. Others were discovered who probably would have encountered very serious difficulty in any college.

More specific reference to particular instances relating to the acceptance or rejection of veterans who, for some reason failed to qualify for admission, will emphasize the significance of the proper use of standardized measuring instruments. During the first week of December, 1946, six veterans who had completed less than four years of high school work applied for admission to the University. In fairness to the veterans themselves as well as to the institution, the question of whether any or all of these applicants should be accepted had to be answered. All six men were referred to the Testing Committee for examination. The examinations revealed wide differences in general mental ability and in high school content. Two of the applicants, as shown in Table I, scored in the upper one-third of college freshmen and were rated as good to excellent college prospects, and two were rated as only fair prospects. The other two ranked very low in general mental ability and in achievement and were rated as poor college risks. This information together with other data concerning each applicant will enable the counselor to encourage those who appear qualified to enroll in the University and to direct into other channels those who rated as only fair or poor college risks.

Table I. Percentile Ranks of Six Non-High School Graduates Who Applied for Admission. (Based on Norms for College Freshmen)

| Case | **General Mental Ability**<br>Henmon Nelson | <br>Otis | Iowa High School Content<br>Total | Rating |
|---|---|---|---|---|
| 1 | 96 | 81 | 84 | Good |
| 2 | 74 | 88 | 69 | Good |
| 3 | 60 | 62 | 37 | Fair |
| 4 | 45 | 32 | 70 | Fair |
| 5 | 20 | 36 | 23 | Poor |
| 6 | 15 | 18 | 12 | Poor |

Questions concerning the predictive value of these examinations may be raised. While a study of individual cases usually does not reflect an accurate total picture, the fact remains that advisement with reference to admission to college has to be an individual basis.

On August 2, 1946 a number of veterans, who had applied the previous week for admission to the University, were referred to the Testing Committee because they were deficient in entrance credits. Seven of these applicants were permitted to enroll in the University in September. On the basis of test results, three of the seven were rated by the examiner as good prospects, three as fair prospects, and one as a poor prospect. The question naturally arises how well they have thus far succeeded in college. As shown in Table II, at the end of the eleventh week of instruction, those who were rated as good risks had received no deficiency grade, those who were classed as fair prospects had one, two, and three deficiencies, respectively, and the one who was rated as a poor risk was failing three of four courses.

Table II. Percentile Ranks of Applicants admitted on the Basis of Entrance Examinations, Their Respective Ratings as College Risks and the Number of Deficiencies at the End of the Eleventh Week. (Based on norms for College Freshmen)

| Case | General Mental Ability<br>Henmon Nelson | <br>Otis | Iowa High School Content<br>Total | <br>Rating | Number of Deficiencies |
|---|---|---|---|---|---|
| 1 | 94 | 62 | 77 | Good | None |
| 2 | 88 | 93 | 75 | Good | None |
| 3 | 73 | 94 | 72 | Good | None |
| 4 | 23 | 36 | 41 | Fair | Two |
| 5 | 30 | 57 | 26 | Fair | One |
| 6 | 70 | 50 | 34 | Fair | Three |
| 7 | 8 | 3 | 37 | Poor | Three |

Seven cases cannot be taken as a basis for any far-reaching conclusions. More extensive studies which will include all cases admitted on the basis of examinations are already in progress. The fact remains, however, that counselors face daily the problem of whether certain applicants should be recommended for college. Evidence seems to indicate the desirability of relying heavily on psychometrics for at least a partial answer. The use of such standardized tests as indicated above makes possible more accurate judgment on the part of both, the counselor and the counselee, than subjective methods alone permit.

Furthermore, a comprehensive admissions testing program will enable the counselor to assist the veteran in the proper selection of his freshman courses. Often a veteran whose general mental ability rating and his total rating in high school content are sufficiently high to admit him to college, ranks extremely low in one subject matter field. In that case the counselor is in position to recommend a non-credit course or special tutoring in the field in which the veteran appears deficient. This type of service has been of inestimable value to large numbers of veterans.

**Advisement With Respect to Occupational Choices:** Many colleges accept responsibility in the matter of aiding veterans in the selection of their occupational or professional fields. Veterans feel that already they have lost time and that they cannot afford to lose any more. They want assurance that they are ‘on the right road" or that they will get on it without much delay. Assisting the veteran, therefore, in making an objective appraisal of himself in terms of vocational possibilities is often of primary significance. That such appraisals must be based on essential data pertaining to the individual's interests, aptitudes, and personal qualities is obvious to any professional worker in the guidance field. It is equally well known that objective standardized tests are indispensable instruments for the accumulation of these essential data.

Reference to specific types of cases will illustrate not only the problems individuals face but more specifically the significant service which may be rendered when a scientific appraisal of some essential factors is made.

**Case 1.** Joe, a veteran 24 years of age, is completing his sophomore year in college and desires to enter the School of Business Administration next semester. He reported to the Guidance Center, hoping to gain some assurance, if possible, that for him accounting was a feasible objective. Interest tests revealed significant computational, business, and clerical interests, and general mental ability test results showed that he ranked in the upper 25 per cent of college sophomores. On the basis of these and other essential data, the counselor could give this veteran a high degree of assurance that accounting was a feasible objective. All this veteran needed was some reassurance that he had chosen a field in which he could succeed.

**Case 2.** J. R., a veteran of 21 years of age, was planning to enter the school of engineering next semester. He wanted to know whether mechanical engineering was a feasible objective. Test results revealed high business and computational and relatively low mechanical and scientific interests. Mental ability and scholastic background ratings were well below the average for freshmen engineers and the physical sciences aptitude rating was in the lowest ten per cent. All essential data, therefore, pointed to the fact that engineering was not a feasible objective for this veteran and that another field should be chosen. With the assistance of the counselor, a more feasible objective was chosen.

**Case 3.** F. R., a veteran 23 years of age, was wondering whether he might enter some type of on the job training in a mechanical field. Interest tests revealed significantly high mechanical, computational, and scientific interests. On general mental ability tests, he excelled 90 per cent of college freshmen. He ranked equally high in mechanical comprehension and his rating on the **Physical Sciences Aptitude Test** was very superior. The counselor was convinced that this veteran was an excellent college prospect, possessing superior mechanical and scientific aptitudes. He was encouraged to enter the School of Engineering, where he has so far made an excellent record. In this case psychometrics revealed much greater possibilities than the veteran himself realized he possessed.

Many other cases could be cited to illustrate the types of problems counselors face. The significant point to consider, however, is the fact that in every case data yielded by objective, scientific measures were essential for an intelligent diagnosis. Services of this type could be expanded greatly to include not only veterans, but all other students as well and a more practical use of a larger variety of tests than is found in most institutions is also possible.

**Psychometrics in the Appraisal of Training While in Military Service:** Another problem closely related to proper advisement and guidance is that of evaluating in terms of sound educational credit the veteran's training and experience while in military service. In appraising such experiences, institutions find it necessary to safeguard their own standards and at the same time deal fairly with the veteran. Many institutions are guided by the handbook developed by the American Council on Education. This handbook serves as a conservative guide for the appraisal of many types of military training.

The American Council on Education also developed the USAFI Tests and recommends their use for the proper appraisal of military experiences, off-duty study and reading. The purpose of the college level tests is not only to enable institutions to determine whether certain prerequisites for more advanced study might be waived but also whether the veteran is entitled to college credit in such fields.

Many institutions began to use their measuring devices almost as soon as veterans appeared on their campuses. At Southern Methodist University, for example, the United States Armed Forces Institute Tests were used exclusively in the beginning of the program. These were later supplemented with a careful selection of Cooperative Tests in English, social science and modern languages. Some veterans who demonstrated a sufficiently high level of competence in a particular field were granted college credit in that field. This policy has enabled many veterans to reduce the amount of time necessary for the completion of their freshman and sophomore work and to enter the upper college level or the professional schools earlier. The appraisal of such training and experiences appears to be much more reliable when carefully prepared, objective, standardized measuring instruments are employed.

It would seem, then, from the foregoing that tests can play a significant role in the advisement of veterans. They supply data which will aid the veteran to determine the feasibility of his entering college; they are important tools in the analysis of vocational possibilities; and they serve as aids in the proper evaluation of education and training while in military service. Test results, however, do not perform their function alone. They must always be presented and interpreted in relation to the total life pattern of the individual.

## ANCIENT MAN IN TEXAS

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This paper will briefly describe the results of twenty years of research on the problem of ancient man in Texas, made principally in Taylor, Nolan, Coke, Callahan, Jones, Shackelford, Mitchell and Stephens Counties of Texas.

Across the first three named counties a highland area extends which belongs to the Edwards Plateau. In the eroded valleys below the northern escarpments of this plateau branches of the Clear Fork of the Brazos River arise and flow northward into that stream. And on the southern side the creek branches flow southward into the Colorado River.

During a long period of the past the Edwards Plateau has been eroding along with the plains which slope away to the north and south below it. The eroded gravels and silts have been deposited in the valleys below and have filled them up and then the softer Permian red beds have given way to the sides and newer valleys have eroded out leaving the original creek beds now as high gravel capped divides between streams. These later formed creek and river valleys are at present going through the filling up process with delta-like deposits, which will eventually fill them up, and in distant days make hilltop stream divides out of them. Patient search during many years has failed to show a single man fractured flint in the highest hill top gravels and conglomerates. It is only in the terrace gravels and silts of the existing valleys that we find the artifacts and the bones of ancient man and more specifically with the latest filling up of these valleys with seven layers of silts and gravels to a depth of thirty to thirty-five feet. At some time of much heavier rainfall during the Pleistocene, the present broad valleys were washed out much deeper than now and were then partly filled with gravel deposits which have since consolidated into conglomerate stone. For some reason some of this conglomerate did not remain and cause the formation of new valleys but evidently most of it was washed away by a new series of floods as it is now only found at certain widely separated favorable localities where the valley streams have cut down through it to the original Permian limestone bed-rock, down to where it was before the deposition of the gravel. There are numerous bones and teeth of the mammoth in this ancient consolidated gravel or conglomerate, but no evidence of man's occupation has ever been found in it. During this flood period there may have been a time of erosion when little or no silt deposition was made. Then came a period when the floods slackened and the deposition began again in the beds of the creek valleys and the first deposit to form was the Lower Clear Fork Silt, which formed to a depth of six feet in the lower valleys and from three to four feet in the mountain valleys. The Lower Clear Fork silt is of a dark red-brown color and in texture is a hard clayey silt filled with caliche nodules and some gravel.

Mammoth bones and teeth have been found by the writer at three sites in Lower Clear Fork deposits but their occurrence is so occasional, compared to their abundance in the next oldest deposit, as to lead one to believe that this period was the one when the mammoth became extinct. Over the top of this deposit in lower river valleys lie twenty-four and one-half feet of later formed silts.

On the top surface of the lower Clear Fork silt at a depth of 24½ feet two Clear Fork dart heads were found embedded with hundreds of flint flakes, abundant charcoal and hearths. At a depth of about thirty feet below top soil surface, down near the water line, the crudely made Jones point was found in 1939 and witnessed by Dr. Clifford Jones and Dr. W. C. Holden of Texas Technological College. In 1930 two thick heavy percussion fractured Abilene points were found embedded in this deposit and at intervals since then similar points have been found. In 1940 a point which in some respects resembles a crude Folsom point was found at a depth of twenty-five feet beneath the soil surface and this was witnessed by Dr. Otto O. Watts of Hardin-Simmons University and E. J. Gardiner of The University of Texas. Also in 1940 the writer found a quartzite mano stone embedded in this deposit at a depth of 27 feet beneath the soil surface. No human bones have ever been found in this silt. The next silt above this is the Upper Clear Fork silt which usually varies from four to eight feet in thickness in lower river valleys, and is two or three feet thick in mountain valleys. This is a lighter colored or pinkish clayey silt and contains hearths, manos, and metates and artifacts of the Clear Fork Culture. Neither human bones nor mammoth bones have been found in the Upper Clear Fork Silt. Above these two Clear Fork silt strata, lie the five Nugent Silts, numbered from below upward. Nugent No. (1), the lowest, is a pink colored clayey silt full of caliche nodules and in it are found many flint flakes, hearths and charcoal. Nugent No. (2) is of brown colored clayey silt and in this at a depth below the soil surface of twenty-one feet a flexed long headed burial was found which is now in the Smithsonian Institution. Nugent Silt No. (3) is of pink colored clayey silt and mostly sterile of remains. Nugent Silt No. (4) has abundant hearths which are almost continuous in the upper two feet. The texture of this silt is tan colored sandy silt and the upper two feet of it is dark with humus and full of mussel shells, charcoal flint chips and animal bones of a recent fauna. Above that is a light tan colored sandy silt known as Nugent Silt (5) which extends up to the soil surface. The soil surface of this contains the hearths of flint using Indians.

Stone slab burials of long headed primitive human types have been found in Nugent Silt (4) at the following depths below the soil surface: Two burials at about seven feet, and one burial at about ten feet below the soil surface.

On acount of the short time allotted, this paper has had to be sketchy but I hope sufficient evidence has been adduced to show that man was in Texas before the mammoth became extinct and gradually moved upward as the valley terraces filled up to a depth of thirty-five feet until at the conquest he stood around hearths on the present valley floors in space thirty-five feet above and in time probably removed thirty thousand years from the homes of his progenitors.

## ECONOMIC IMPLICATIONS IN THE PRESENT TRENDS TOWARD MONOPOLY CONTROL OF TECHNOLOGY

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This history of a civilization might well be written in terms of how adaptable its institutional concepts remained to the shock of technological change.

The following quotation from Dr. C. E. Ayres' new book, **The Devine Right of Capital** forcefully demonstrates this thought.

> "Western Europe was the frontier of a tremendously old and rich Mediterranean culture. Thus, the iron age which Watt ushered in really began when the smelting of iron was discovered in what is now Turkey some time before the siege of Troy. The Romans conquered Gaul and brought all their tools and accoutrements, all their arts and all their knowledge of materials, across the Alps into their new province. Then they lost the province. It was not so much that Rome fell as that Gaul fell away. The Roman Empire persisted

> almost to the time of Columbus, but western Europe was not a part of it.
>
> Thus, the freedom of the frontier was intensified by independence. We used to think of medieval civilization as utterly rigid and dogma-ridden, hidebound and traditionalized in every way; and so it was by comparison with modern Europe or America. But compared with the other great centers of culture at that time, European society was a brawling infant, far less tradition-ridden than China, or India, or Islam, or Byzantium. That is why contact with Islam or with China altered Europe so much more than it did Islam or China."[1]

In this picture of Western Europe can be found the story of a young America whose allegiance to the traditions of the old world were not nearly so strong as the exigencies of frontier life. In America there was no long standing economic and social order which had to be overcome before the benefits of the so-called "industrial revolutions," which have been going on since the dawn of history, could come to pass. Capitalism, which has become quite respectable by the time America was discovered, found virgin territory in this country, because by capitalism's own nature it thrives best, and possibly only, in frontier territory where opportunity exists for expansion through development of natural resources for an ever-increasing market.

What is now called the "American technology" got started early. Conditions of frontier life presented many new problems for which there was little precedent to indicate a solution, so ingenuity and experimentation were quite in order. The key to the direction which the ingenuity and experimentation took is to be found in the problems of the great distances to traverse, the shortage of labor, and the great abundance of natural resources which needed to be converted into usable goods.

The value of technology was recognized early in our history. The first patent issued in America was given in 1641 to Samuel Winslow by Massachusetts Bay Colony for a new process of making salt. Five years later Joseph Jenkes received the first American patent on machinery.[2] Congress, after passing a patent law in 1790, which incidentally proved too strict and, upon modification in 1793 proved too broad, established the present patent law in 1836.[3]

It is important to note that invention was not confined to the relatively few geniuses which society is supposed to produce from time to time, but was a matter of interest to even the rank and file. The number of patents issued jumped from 25 a year under the original patent act to over 2500 a year in the 1850's.[4] There can be little doubt that, in the early years at least, the patent law has greatly stimulated technological development.

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[1] Page 20.

[2] Binning, Arthur C., **The Rise of American Economic Life.** (New York; Charles Scribner's Sons), 1943. p. 247.

[3] Shannon, Fred Albert, **America's Economic Growth.** (New York; Macmillan Company) p. 205.

[4] Shannon, **loc. cit.**

As technology advanced it became more and more complex. Production moved from the workman's home or workshop to the small factory, and from the small factory to the large. This change had far reaching effect on social, economic and political institutions. Time or space does not permit a detailed analysis of these effects, but it is necessary to mention some of them as they relate to economic developments that have taken place during recent years.

One result of technological changes which made production more and more dependent on large accumulations of capital, although somewhat intangible, is that it tended to divide the community into those who continued to believe in existing economic institutional concepts because of practical returns and those whose allegiance to them was due to aspiration or hope. It was not unusual that those of the community who found themselves controlling this new technology should loyally support the institutions of private property, profit motive, individualism, individual initiative, freedom of contract, the price system, and the free market. What is more difficult to understand is why those, composing an ever-increasing portion of the community, finding themselves being more and more relegated to a semi-propertyless status, whereby their relationship to the production process, they were to become more and more dependent rather than independent, continued to loyally support these institutions.

It would appear that the partial explanation for this allegiance through hope, which is still strong today, is to be found in some of our early social and political concepts. Even though the fathers of our Constitution took special precautions to protect and preserve the right of property and to cushion the country against an "excess of democracy," such thoughts as "equality of man," "inalienable rights" and "freedom of opportunity" were freely expressed and came to be a part of our social and political relationships. It is only natural that they should carry over into the economic sphere, and sustain aspirations there.

Part of the explanation might also be found in the fact that the produce of industry was spread broadly, if sometimes thinly, over the whole community, and this served to keep aspirations high. Periodic prosperity was usually able to recharge the fires of hope which tended to burn low during periods of economic depression, when interdependence is more clearly revealed.

This analysis is not meant to be comprehensive or all-inclusive but it does tend to aid in the understanding of the somewhat paradoxical situation which we find ourselves facing today, that of finding, on the part of the majority of people, an almost blind faith in the "free" market, the price-system and in "free" enterprise, when there is ample evidence to support the contention that none of them exists in practice as they do in concept.

How long and how successfully the tremendously advanced American technology can be sustained, or further advanced, in this institutional setting is a question of shocking importance. For the moment, however, it is necessary to pick up other results of technological change on our economy, and we will dispose of this question at present with the comment that the situation today is somewhat analogous to that of strapping a B-29 engine to a Model T chassis in the expectation of improving transportation.

As production became more and more dependent on large capital accumulations in the form of machines and other equipment the control over production passed into fewer and fewer hands. This, of course, tended to direct the consumer spending of the community away from the many producers into the hands of fewer and fewer, which in turn led to unbalanced division of the "industrial pie."

The short-run effects of mal-distribution of the industrial pie can be neutralized in an economy where ample expansion is present to insure immediate return of savings to production through the mechanism of investment. Of course, in a country as vast as America it was possible, and often the practice, for high profits to be made at the expense of labor in one section of the country and invested on the frontier, or in some other section of the country, far from the area where the exploitation took place. There was no escape from the effects of inequitable division of production in this case, and for those so exploited the result was often poverty and suffering, while the economy as a whole continued to expand.

As indicated above, the deadly effects of inequitable division of the produce of industry can be escaped in the short-run through the escape value of investment. The long-run effect, however, is dangerous in that it extends and perpetuates the power of the few who control production, and leads to deeply entrenched vested interest groups. This, of course, has been the case in America as evidenced by the extreme concentration of economic control which exists in the economy today.

Questions may well be asked as to why the concentration of economic control so shocking today has become a characteristic of the economy only since the turn of the century and did not occur sooner. The answer to this question is probably to be found in the nature of the technological change which has characterized America's development in the past, basic changes which have taken place in the economy, and the relationship of both these factors to present day technological research.

Historically, technoligical change has been unpredictable and was likely to occur in any area where so much was needed to increase production and enhance its profits. It traditionally has been no respecter of person or position, and as a consequence has been a neutralizer of vested interest power. Traditionally, also, it has been the result of cumulative activity of individuals or small groups of individuals, who, in turn, received, and benefitted by, the protection of the patent system. Those who managed to be in control of productive factors, in order to maintain, or improve, their trading position had to do so by the socially beneficial, if seemingly outmoded, expedient of production of a greater amount of better goods at a lower price. Whenever two pockets of vested power did clash because of the advent of a new technique the conflict was usually settled on the basis of which technique most benefitted the public and not on the basis of which company had the greatest assemblage of patent attorneys. Here we find technology as a dynamic in the economy, a definite stimulant to economic arteries which might have otherwise hardened.

In an economy where markets are strong as a result of expansion, competition is not nearly so dangerous, and there is less temptation for vested interest groups to hold each other in awe, and to settle their conflicts by agreement between themselves to conspire against the public. A new technique becomes a weapon with which to beat down the competitor through more efficient production and thus generate greater and greater profits. There is no need to settle for less than this.

Somewhere around the turn of the century and after, the tremendous internal expansion which had characterized the American economy for almost two centuries began to slow. This, of course, had its effects on the investment activity, the decrease of which was reflected in the weakening of domestic markets. When markets become weaker competition becomes highly dangerous, and usually not to be resorted to if it can be avoided. With typical "American ingenuity" it was avoided by what is commonly referred to as the merger movement, which took place during the early 1900's and after World War I.

By the end of 1929 this movement had affected practically all important industries. In iron and steel 217 companies were brought under control by 25 mergers. Eleven mergers in the electric equipment industry controlled 71 companies. There were 3 telephone and telegraph mergers which controlled 627 companies. This same thing was characteristic of agricultural equipment, railroad equipment, chemicals, motion pictures, food products and many other industries. [5]

That the merger movement greatly concentrated economic control is hardly to be questioned. The National Resources Committee of the Federal Government in its publication, **The Structure of the American Economy** reveals that 200 of the largest non-financial corporations and 50 of the largest financial corporations own collectively 34% of the assets of industrial corporations, 48% of the assets of all commercial banks, 75% of the assets of all utilities, and 95% of all railroad assets. As of 1935 the collective assets of this group totaled approximately 100 billion dollars.

The merger movement, resulting as it did in great blocks of concentratedly controlled and deeply entrenched economic power had a significant effect on the nature and extent of technological research as well as the function of the patent system.

From 1921 to 1938 people employed industrial research increased approximately 300%. Between 1927 and 1938 research personnel in iron and steel and their products increased 189.4%, petroleum and its products 538.7%, radio apparatus 1600%, agricultural implements 184.7%, chemicals 175.5%, and motor vehicles, bodies and parts 190.2%.[6]

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[5] J. T. Flynn, **Merge or Submerge.** New Republic, July 2, 1930, p. 70.

Most present day inventions are the products of modernly-equipped laboratories. The isolated individual inventer who worked on his own and usually for himself has given way to a group of highly trained specialists to work in these laboratories. The techniques or inventions developed by these specialists become the property of the corporation.

This transition which has taken place in the nature of invention can be explained in three ways. First, research still plays an important role in the improvement of a concern's competitive position by providing new features, parts, or gadgets to be added to that firm's products so as to sustain or enlarge customer appeal. Second, modern research is expensive and consequently confined to those concerns which have resources to carry it on. Third, and highly significant from the standpoint of social welfare, vested interest groups have increased their industrial research so as to better control any invention, or inventions which might endanger their supremacy in the field and thereby jeopardize their investments. Stated another way; through research, the innovations of tomorrow, which might destroy the vested interests of today, are neutralized and brought under control.

Not only has industrial research passed from the individual inventer to the corporation, but it has become concentratedly controlled by relatively few of these corporations. In 1938, one-third of the nation's research workers were employed by only 13 companies. One half of the nation's research workers were employed by only 45 companies. More striking yet is the revelation that 36 of these 45 companies are owned and controlled by the 200 largest non-financial corporations referred to earlier.[7]

The concentration in industrial research is further shown in the ownership of patents. According to a recent study[8] 450 corporations, all having assets of more than 50 million dollars each, own 22% of all corporate patents. This is approximately ½ of 1% of all corporations owning patents. More astounding still is that only 22 corporations own 15% of all corporate patents.

Concentration of control over industrial research and the ensuing patents have placed in the hands of the vested interest groups the tools with which they can and are not only perpetuating themselves, but extending their power over the vast resources of this country and the world at large. This, of course, is contrary to the original meaning of the patent system and to the very foundation of democratic capitalism.

Patents today may be classified into three broad categories: (1) Those which concerns take out to improve their products and thereby stabilize or further their competitive position; (2) Those which concerns take out on every possible machine or technique so as to eliminate any other concerns or individuals from being able to receive a patent which might in any way jeopardize their control of the field. This is commonly referred to as the "fencing out" patent. (3) Those patents taken out on improvements or possible changes in machines which are already in existence and patented by a competitor so as to keep that concern from improving its own machines. This is commonly referred to as the "fencing in" patent.

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[6] Temporary National Economic Committee, U. S. Senate, Monograph No. 22, p. 209.

[7] Industrial Research and Changing Technology, Works Progress Administration, 1938, p. 45.

[8] Reese, James E. **The United States Patent System.** (Doctoral Dissertation, University of Texas) 1941.

Thurman Arnold in his testimony before the Committee on Patents of the United States Senate classified patent evils into the following categories or types of patents: (1) The blitzkreig patent; (2) the umbrella patent; (3) the accordian patent; (4) the bottleneck patent; (5) the patent pool; (6) licenses which restrict use; (7) licenses which retrict production; (8) patents or licenses which fix price; (9) blocking or fencing patents. [9]

Problems and dangers which accrue from the abuse of the patent system are recognized even by those who speak for business itself. The following quotation from an article in Fortune Magazine very clearly outlines the most important aspects of the problem:

> "No one would destroy the simple, individual, seventeen-year patent monopoly as a shield and incentive for the small man, venture capital, and new enterprise. It has worked, and will work better when the overgrowth is cleared. But it must end at seventeen years. And great corporate combinations must be deprived of the devices to hold on to patent monopolies in perpetuity and dictate price and production in broad market areas that should long ago have been free. The improvement patent device must be cast out. The patent that lies unused must be thrown open, after a reasonable period, to unrestrictive licensing. Two totally different, basis, but competing inventions in the same field (incandescent and flourescent lighting) must not be held under one corporate segis."[10]

There can be little doubt that such policies as price-maintenance, production-restriction, and other self-perpetuating policies, made possible through vested interest exploitation of research and the patent system, is taking its toll in the economic life of America and the world. What goods the people shall enjoy, and how much, is more and more being determined by what small, but powerful, groups feel is profitable and most likely to strengthen and benefit themselves. The inevitable result of this policy is to reduce the rest of the community to the role of subjects who must look to those who control production for sustenance.

It is an interesting commentary on the problems facing America today to note that a people who have been so careful to protect themselves from a political dictatorship have been so blind to the dangers of economic dictatorship. It is also a sad, but highly significant commentary, on American problems to note that during the recent war unemployment disappeared and production rose to a peak new in the history of nations, but to note further that during the years preceding the war, and apparently those which are to follow it, matters of greatest concern are employment and production.

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[9] Committees on Patents, U. S. Senate. **Hearings**, Part 7, July 31, August 3 and 4, 1942, pp. 3295-3308.

[10] War, Peace, and the Patent System. Fortune Magazine, August, 1942, p. 141.

There appears to be no question of the productivity of the American technology. Questions do arise, however, when the adequateness of the social and economic institutional concepts under which this technology is to be put to work, are considered. It is probably true also that the degree of modification which will be required on the existing institutional pattern to insure full use of technology will depend on how soon and how objectively the job of modification is undertaken.

What the future will bring in the way of an answer to America's economic problems, of course, remains to be seen. It is to be hoped, however, that existing traditional economic concepts will not form a barricade which will deny to the people of this country and to the world the promises which science and technology holds out to them.

It is to be hoped that the decline of American industrial power, when and if such a thing should happen, will not be ascribed by historians to institutional arthritis.

## THE ROLE OF THE COLLEGE ORIENTATION COURSE IN THE SOCIAL SCIENCES

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In the period between the two World Wars which have occurred in the Twentieth Century, the social sciences expanded their offerings greatly in nearly every college and university in the nation. But this expansion did not keep pace with the development of the physical sciences either elsewhere or with us in Texas. Indeed it has not furnished us the leadership necessary to save us from plenty of confusion in either the domestic or the international scene. Furthermore, at present there is no startling evidence that a still greater expansion of the social sciences in the future will serve us any better than the present has been served by such an expansion in the past.

The past has seen: (1) an increase in the number of courses offered in each department of the social science field, (2) a steady elaboration and an increase of specialization in courses, and (3) a phenomenal growth in the departments of sociology and psychology. Research in the social sciences, however, has been lagging far behind research in the physical and biological fields. Less money is forthcoming for such enterprises from industry for various reasons, and from the state—and the national—government for the same reasons. It is proving very difficult to get a place for the social sciences in the projected National Science Foundation. There is every evidence that the social sciences must prove themselves against all odds that they are indispensable.

Perhaps one reason they have not done so before is because they have failed to give college students who have been "exposed" to them an adequate perspective either for their college experience or for their careers after college. If leaders in the practical workaday world of financ, technology, business, and politics, who increasingly come from the ranks of college men, found life given some real dimensions in the light of their experiences in the classes of teachers in the social fields, they would not only support the advancement of the social sciences with more vigor, but they would bear the fruits of this advancement in their practical lives.

The place for the social sciences to begin with this task, however, is with the freshman. It is this fact that makes the full year orientation course for the freshman of supreme importance. At least it can be of supreme importance; that is, in case it establishes a frame of reference and a perspective such as I have suggested above.

By perspective I mean a view of the larger dimensions of the educational career that lies ahead in height, width, depth, and length—in intension and extension, the areas to be covered, the importance of thoroughness, the advantages accruing to the individual and society by covering these areas, and the desirability of developing scientific modes of thought. By frame of reference, I mean a unifying organization of the field of knowledge in the student's mind, so that as he learns in its rightful place in the total structure, or in the unified field. He will in such a case not "lose sight of the woods as he observes a clump of grass or the individual trees." He will not come to the end of his college career knowing a large mass of unrelated things that can not be assimilated to one another nor integrated and assimilated into the patterns of his life as a family man, a worker, a church member, a participant in recreational activities, or a citizen of his community, his nation, or his world. He will rather come to the end of his college experience knowing the point at which he began, the road he has covered, and the fact that he has got a lot of road to cover yet. But he will know that there will be others on the road, and he will know more about where he belongs in relation to his fellow travelers.

I must, however, be far more concrete and more specific about what I have in mind as this frame of reference which ought to be constructed by the freshman with the aid of his teachers, courses, readings, and textbooks in the social sciences. I think I can make myself clear by outlining what I consider to be the five most important questions for which we may seek the answers; questions about the five most inclusive problems faced by man, problems equally scientific and human. In order these are:

First, what are the forces that operate to make and break persons, families, civilizations, cultures, races, nations, classes, economic systems, and so on? Second, how have these forces worked in history and how do they work today? Third, does mankind have control over these forces? If so, how much control can he exercise? Fourth, assuming that he has enough control over these factors to influence the course of social change toward the attainment of given goals, what kind of goals are most desirable to seek? What kind of world does man want to live in? Can he best live in? Does he want a Nazi world, a world of laissez faire, monopolist capitalism, communism, or of democracy? Of war, hate, famine, pestilence, or of peace, active good will, abundance, buoyant health? What do we want to eliminate that now is and to bring to pass that now is not? Fifth, by what techniques can we best achieve a more desirable world than we have?

These questions cannot be answered completely either in the freshman year or later, but they are challenges that last for a life time of study and research. They are of universal interest, and every discipline in the college curriculum is based on some aspect of these problems. It is in the social sciences, however, that they have their focus—in sociology, history, anthropology, psychology, economics, government, religion, and philosophy. It is my idea, then, that these questions ought to stand at the head of five divisions of the social science orientation course.

This course, in other words, ought to begin with the question, "What are the forces that make and break persons, families, races, nations, and cultures?" The answer, general at first, can become far more specific and meaningful in elaboration. When the student is told that he may inquire into the fields of the physical sciences for knowledge of the physical forces impinging upon man and helping to make or break him, he begins the study of these sciences with more understanding of their place in the total scheme of things if they are presented to him as a set of scientific and life problems in the projected frame of reference. He sees more clearly where the study of the physical sciences touch not only his life but the whole life of society. He appreciates also how they belong within the organic fullness of a well-rounded education. He will see that training in the physical sciences alone, however, is at best only a partial education; for physical forces such as climate, topography, tides, rivers, coast lines, and the presence or absence of given natural resources constitute only one set of factors influencing man and requiring controls. He can thus understand that technological controls can be applied only to the physical factors that impinge upon man—to protection and subsistence; that machinery cannot bring in the kingdom of God; that machines can only be tools to further this cause or to develop on earth an atomic inferno. He will discover that becoming a chemist or an engineer does not fit him for creative citizenship, if a chemist or an engineer is all he becomes. Wild Bill Murray used to say that Herbert Hoover really proved himself an engineer, because nobody could have ditched, drained, and damned the country more quickly than he did.

The social science course also furnishes an opportunity to outline the biological, psychological, and cultural factors that make and break man as it attempts to answer question one, and to put each of these factors in its proper place in its dynamic interrelations with all other factors. For example it can show the importance of the study of genetics and the application of genetics in a program of eugenics while indicating clearly that the world can go to its doom from the force of other factors long before eugenics can even take its first feeble steps in the direction of racial improvement. It can outline the nature of human nature by comparing human behavior in varying cultures and showing how biological drives are modified in their expression by cultural definitions of ways in which they may or may not be expressed. It may at the same time demonstrate that people who behave unlike us are just as human as we are, and fundamentally of the same nature. It can show that racial theories of history are inadequate: that any race can assimilate to any culture that is in keeping with fundamental human needs, but that no race, without courting destruction, can assimilate to any culture that throws barriers in the way of these fundamental satisfactions. It can indicate clearly the importance of population studies in social planning. It can show that biological, psychological, familial, community, and cultural factors interact in the making of personality, whether genius or moron, good citizen or criminal, saint or sinner. It can surely point out the compatibility within rational limitations of the concept of individual freedom and responsibility with the equally important concept that no behavior is uncaused, or free from the influence of any factor operating in the situation in which it occurs. It can create, in the student, a sympathetic appreciation of the biological, psychological, and cultural factors in the failures of others, without developing in that student a habit of rationalizing his own failures by saying that he was either born to fail or too poor to succeed in creative achievements. It can clearly show that people less fortunate may be inherently equal to himself; that a man who later becomes an oil millionaire in Texas may have earlier used the oil oozing out of the earth in his back yard to kill the fleas on his hogs before he realized there was anything else that the stuff was good for! It required neither education nor intelligence. He was only "doing what comes naturally!" The curve of the distribution of wealth is vastly different from the curve representing the distribution of intelligence. The individual intelligence of an Einstein would appear as sheer idiocy without the realtivity of his cultural background. Einstein and Edison would have been as devoid of the discoveries and inventions they have made as of clothes, if they had grown up among Kalahari Bushmen: and that is that, "By Ford!"

In addition to demonstrating the dynamic interactive relationships of physical, biological, psychological, and cultural factors in human life, the orientation course can indicate that social change is initiated by events that occur in each of these realms and that all attempts at controlling the direction of change must take all these forces into consideration. This is, however, to anticipate the third question of the year as to whether and or to what extent it is possible to control the direction of social change and modify the course of history. It is therefore necessary to introduce the study of this third question by an extended study of the second; that is, by studying the way in which the four sets of forces outlined above have worked in history and how they operate today to make and break persons, families, civilizations, races, nations, and cultures.

This is the point in our frame of reference at which history comes in. It is my humble opinion that the social science orientation course is often just a course in history; badly taught, which surveys everything from A to Izard in a disjointed way, without any idea in the mind of the instructor of fitting this about Greece and that about Rome, Jupiter, Venus, or Hannibal into any historical process, thought structure, or applicable relationship to the present and the future. No wonder that the student so often comes to the end of the course, saying,

"The cow is in the parlor,
The cat is in the lake,
The baby's in the ash can,
What difference does it make?"

If instead of pursuing such a haphazard course, the student is led to see that he can answer question two of the five being asked by the study of history, and that he can obtain aid in the answer to the other four, that discipline then begins to live in his own life, in the present, and in the future. In this way the "word becomes flesh," and history becomes a process, flowing out of the past through the present into the future through human beings, including ourselves, instead of some pages in a book to be read some time before the beginning of examinations.

Many books in social science orientation pay too little attention to history. Some are nothing else. Some proceed on the assumption that an orientation course ought to give a little of this in economics and a little of that in government, with the idea that the student will have at least a speaking acquaintance with the subject when he becomes a sophomore and enrolls in any course in the general field. Such texts are sometimes put together like a freight train: only a freight train does have couplings. An effective text, to fulfill the conditions of our frame of reference, must be neither a survey course in history nor a train of freight cars devoid of contents and without couplings. Every section must be loaded with content, organically related with every other section, and driving for the grand central station. It must ask with Sumner Welles, "Where are we heading?"

The third question leads us to ask whether mankind has any control over his destiny, whether we are at the throttle of the historical train, and whether it is possible for us to choose our own track. This is our question at the moment as we follow the news about the doings of the peace conferences and of the United Nations Organization with the feeling, "I wonder what will happen next?"

The freshman in college can at least become aware of the magnitude of this problem and of the vastness of human resources that can be applied in exercising far more control over the direction of social change than we have ever done in the past. He can, also, be made aware of the possibility of keeping planning and democracy completely compatible. It is surely at such points as these that economics, government, sociology and psychology find a place.

These curricula also have an important function in answering the fourth and fifth questions: that is, "What kind of a world do we want to live in—Nazi, Fascist, laissez faire, Communist, democratic, sensate, hell-bent for heaven, humanly centered, thing-minded, or power-mad. Probably the freshman ought to be made acquainted with Aldous Huxley's BRAVE NEW WORLD as a glaring example of what we may better not become. Is such a world "What we have been fighting for?"

Then, if we can decide that there are certain things we want to leave out of the world tomorrow, and others things that we want to keep, and still others that we want to add, the last question is, "How are we going to succeed?" This is the question of the applied sciences and technologies. The freshman will reach them later on, but he ought to discover now that they are there to reach and how they are related to what he is studying now.

Every one of these questions raises to high heaven the obvious necessity for carrying on research in the social sciences—pure research for the sake of doing it and for the sake of the information that can be obtained, yes. Objective research unclouded by wishful thinking, of course. But, the man who carries on research without any idea that the information he gathers and the principles he unfolds may be put to any practical use, is, more frequently than not, either a moron or a myth! The urgent need for the discovery of atomic power ushered it into existence much earlier than it would have otherwise occurred. And, if its occurrence does not emphasize, in our minds, the urgency of social research for the purpose of gaining social knowledge that can be socially applied, we may get that knowledge so slowly that we may not have time to get it at all. The handwriting on the wall says more than the three words, "Kilroy was here!" It says in words which facts make unmistakable, "It is later than you think!"

Freshmen, sophomores, juniors, college professors, university presiidents, regents, trustees, and members of the legislature must learn the value of social research. I wish I could report that the facilities for such research have grown proportionately in Texas. But I cannot make such a report. We have added courses in social research to our curricula. We have given greater emphasis to the learning of statistical techniques in sociology, economics, and business administration; but we have been too greatly restricted in what we may write statistics about!

We all know that cancer research is imperative. We know that the University of Texas can do that with large amounts of money needed for the purpose. But we had better work for equal support for research projects in the social sciences for all the colleges in our state and everywhere else.

I do not know of any college in Texas which has been able to blend research and teaching with any degree of adequacy in any social field. At Texas Christian University we have had the good fortune to be the recipients of a modest gift, which will grow from year to year, for research and publication in the social sciences. It is what we call the Leo Potishman Foundation. We have just published our first research studies, and we are highly pleased with the response. No doubt other schools in the state are doing far more than we in this respect; but none of us will be able to do enough unless we are willing to cooperate. It will probably take a great deal of pooling of our meager resources among the colleges of Texas to get a respectable job done at all.

I think I have discovered a tendency of departments in various schools to fall at certain points into petty jealousies, which cause them to discredit sister departments in other schools instead of urging them on to greater efforts. I hope I am wrong. I don't know enough about any of the things I have been discussing, and probably instead of coming over here "I should of stayed in bed." It may be that my demonstration of ignorance today, about the shape we are in, might motivate us to undertake, jointly, to find out more about how far we have come as sister departments, where we need to go, and the direction we should take to get there. If this much has been achieved, it may be that I have not been merely wasting your time and my breath. I can, at least, say in the stilted tones sometimes used at the lectern, "Here endeth the reading."

## NAVAJO-FEDERAL RELATIONS AS A SOCIAL-CULTURAL PROBLEM

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Located in Northeastern Arizona and extending across the borders into Northern New Mexico and Eastern Utah is an area of almost twenty-five thousand square miles, equal to that of West Virginia and almost three times that of Massachusetts. This vast area, known as the Navajo Reservation, consists of semiarid desert plateaus and mountain ranges, which are drastically limited in water supply and vegetation necessary for the sustenance of animal and human life. The thin soil is unable to produce adequately for the increasing flocks which graze upon it and is now seriously threatened by erosion through overgrazing. Consequently, 50,000 Navajo are facing a crisis which is tending toward catastrophe. With relatively swift multiplying of people and the seeming necessity of increasing the flocks, the grass has been gradually reduced from the range and in some parts almost eliminated. In spite of a grass shortage the Navajo population continued to grow and the size of the flocks continued to increase, while at the same time the range became less able to cope with the burden placed upon it.

It is evident that the American public is not aware of the seriousness of the present Navajo situation or that America's self-respect is involved in this problem. We have failed to fulfill our obligations to the Indian and few have been interested enough to give any consideration to the welfare of one of the most important minority groups of the American democracy. Today the Navajo situation is one of the most bewildering minority problems facing the United States government. This problem is a complex combination of Indian heritage, Indian customs, and Indian ways of life, which are in conflict with the Navajo Indian Service's scientific program of soil conservation and methods of social reform. The scene is a dramatic demonstration of the often self-contradictory process of social change which, largely through lack of foresight and future planning on the part of the Bureau of Indian Affairs, has brought critical social disorganization which is evident throughout the Reservation.

The removal of the vegetative cover in the Navajo country presents a particularly serious problem since the native flora's hold on the land is at best precarious. Under conditions of overgrazing, heavy rains place an excessive burden on both the area receiving the rain and the drainage areas many miles below. Incalculable quantities of valuable top soil are carried off with every storm and deposited many miles away.

In the past seventy years there has developed nearly an eight-fold increase in the livestock load on the Navajo range. The rapid expansion of both the human and the animal population now appears spectacular, but the growth has been a gradual one and the Navajo are unable to comprehend what has been happening to their most important natural resource, the range.[1]

In 1933, when it was realized that the range was carrying over twice its capacity of stock, rumors began to be spread as to the necessity of removing some of the excess animals. To the Navajo such a move was unthinkable, for the outright removal of their flocks and herds was in direct contradiction to decades of ceaseless effort on the part of every government, official, trader, and missionary among the Navajo to lead them to increase their flocks.

John Collier, who became Commissioner of Indian Affairs in 1933, realized the seriousness of the situation but failed to appreciate the psychological and cultural background of the Navajo. Consequently, he took immediate and drastic steps to reduce the livestock on the Navajo Reservation without giving proper consideration to adjusting the Indian to the administration's program of saving the soil as a means of saving the Navajo.

The main objects of the Navajo program are "human adjustment and land rehabilitation,"[2] but in practice emphasis has been placed on land rather than upon human adjustment and rehabilitation. From lack of funds the administration has been unable to carry out its part of the program, but it has been persistent in its stock reduction program; consequently the government has not supplemented the Indian's loss in sheep by giving him ample work to help carry him over from his sheep culture to agriculture. The program has been so bewildering to the Indian that he has become a disgruntled man lost in a wilderness of words and theories that he can not understand. The Navajo was in total ignorance of the reasons behind the hundreds of questions asked him. Ignorance led to uneasiness and suspicion; and from this state of mind the step was short to fear and hostility, and finally to an utter loss of faith in the government administration. With each new development he grew more bitter and more stubborn, fully believing that his economic security was gone and that his last vista of freedom had vanished. Here the Navajo program "stalled."

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[1] Gehardt Laves, **Land Management in the Navajo Area** (Window Rock: Navajo Service School Bulletin No. 3, 1937), p. 2.

[2] United States Department of Interior, **Navajo Policies and Program** (Washington, D. C.: Office of Indian Affairs, May 1, 1939), p. 1.

In brief the Navajo problem is the result of too many people and too many sheep in too small an area, and the failure to adjust the Indian properly to the present administration's program of saving the soil as a means of saving the Navajo. The problem is further aggravated by failure to reconcile the tenacious devotion of the Navajo people to their customs and sheep-culture with the policy of the aggressive and able soil conservationists, who were determined to save the soil at any cost.

The Navajo situation as a sociological problem centers around the group's social-cultural values[3] in conflict with enforced changes in their pastoral economy; an economy which is basic to Navajo civilization.

The sociological phases of the Navajo situation are closely related to the fact that under present conditions the Navajo have a very limited income. Furthermore, the specialization and limitations of the pastoral economy of these Indians have become associated with fixed cultural patterns and uses.[4] So long as the natural resources of the Navajo country could cope with the ever increasing number of animals on the Reservation, Navajo economy remained intact, but when the range was no longer plentiful and the land was wasting away, through the devastating process of soil erosion, the Navajo were suddenly confronted with a situation which was foreign to their daily routine of life. Basic then, to the situation, is the necessity of a conservation program to save the Navajo's land. To the Navajo, the problem which they face is a strange paradoxical process. It is the policy of the Indian

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[3] The term "social-cultural" as used in this study implies that the human relationships are of both a social and cultural nature, and that these two words are so inter-related, and so dependent, one upon the other, that it is impossible to make a clear distinction between the two. Human nature is both social and cultural, and "the values which recent sociology has been calling 'social' are often really cultural values," furthermore, "all culture objects are the outcome of social or group experience . . ."—Clarence M. Case, "The Value Concept in Sociology," **Sociology and Social Research**, 23:423, May-June, 1939.

[4] C. Daryll Forde, **Habitat, Economy and Society** (New York: Harcourt Brace and Co., 1937), p. 394.

Service to develop a conservation program of saving the land as a means of saving the people, but the Navajo see only inconsistency in the program since, to them, it has stressed the saving of the land regardless of the economic and social cost to the people.

The situation has developed into more than the necessity of a scientific plan of conserving the natural resources of the Reservation; there is need for the consideration of the human factor since the cultural and social elements are also involved. As a rule, new social developments come slowly, and in due time a culture may make some definite changes without any break in its continuity. The core of Navajo culture is of an economic nature, based on a pastoral industry, and as such, under present conditions it has become comparatively unstable. A sudden change has taken place in the general routine of the life of the Navajo which is making it difficult for the group to maintain its integrity, and a serious disruption is in progress.

It is very evident that the Navajo, a once happy, proud and independent people, are emotionally upset; they are in a stage of mental depression. Fifteen years ago the Navajo Indians were a proud, independent, almost hauty people. They were happy, prosperous, and thought in terms of their flocks, their land, and "getting ahead in the world." But the past twelve years have seen a tremendous change. Much of that independent spirit has been broken, and with this has come a sociological problem to the Reservation which will not be solved in many generations.

There is much to indicate that the Navajo are now in a stage of mental depression. The present writer has heard the question "What's the use?" so often that it grieves him each time he hears it. A man who has worked a lifetime and has increased his flock to a thousand head, hoping to help his children get started in life, finds his flock reduced within a few years to two hundred head. Thus his income is cut down well over half, his status is lowered, and his feeling of security is gone. The Navajo's spirit is broken, for his economy has been struck a vital blow. He continually worries, for he knows not what he and his children will have to eat and wear. However, the Navajo's concern is by no means limited to the material results of the loss of his flocks and herds. He sees in the reduction of his stock the serious problem which the young people who desire to marry and go into the sheep business for themselves face.

The father of a very large family has this to say:

> We feel very downhearted when our children get married because we can't help them get started out and accumulate flocks. When a couple is married, they are told by the government to get sheep from their father, but father doesn't have enough. They want to accumulate and build up a flock, but they are told that they cannot. It was different with me; my father and mother said to me, "You can't always live with us so you take care of your own sheep and save." That is the way I got my start, but I can't do that for my children and it makes me feel bad inside. Young people working

> for wages turn out to be no good. They spend all their money for foolishness and they are no good to their own people . . . They don't learn to care for the sheep or how to farm, and if they are thrown out of work they just loaf and get into trouble . . . This thing is ruining our young people. When I was young, we talked about our homes, our flocks, and getting ahead, but now the young people haven't anything to look forward to. Of course under these conditions we can expect our children to be idle and become lazy and crazy like the white young people do. A lot of young boys have nothing else to do but to get on a horse and ride around and get into mischief. Our children are a lot more immoral than they used to be; there is a lot more common law marriage and illegitimacy too.[5]

While many of the horses that the Navajo were asked to sell were unproductive and of no particular use to their owners, they had a high prestige value to the Indians. For more than a century the social position of an ambitious young Navajo, desiring to raise himself in the esteem of his fellow tribesmen, depended largely upon his success in accumulating the largest possible number of horses. To let his horses go was to break this long tradition and to lower his own status. In Navajo society a collection of horses is equivalent to the orchids and candy which the young suitor in white man's society presents to the lady of his choice.

The move to reduce the horses on the Reservation came at a time when the already bewildered and upset Navajo looked with suspicion upon any action made by Collier and his agents. He was feeling the results of the reduction program and the loss of his goats, which had deprived him and his children of their main source of milk supply. He was daily becoming more embittered and his confidence in the Indian Service was rapidly waning. His fears were ever mounting, playing upon his keen but suspicious imagination until he found himself living in a world of dread, continually asking himself, "What next?" This situation is evidenced by the following comment:

> Many of the people have lost their ambition and pride. Every day I hear people say, "What's the use? What's the use of trying to do anything?" They have just gotten to the place where they don't care and so that is the way they talk . . . We don't want to see our people get that way for then they will be clear down, and they won't be able to rise again. When we have a meeting, even among ourselves, our people show great fear, almost to the point of being panicky. The people feel very insecure. They say that they don't know what to do or what to expect.[6]

Thousands of sheep and goats have been grazed on the poorest of ranges and were not considered fit for human consumption. The field men, realizing this fact and evidently having little consideration for the feelings of the Indians, shot thousands of goats and left them in heaps to rot. In Navajo Canyon three thousand five hundred head were shot at one time.[7] Throughout the Reservation hundreds of goats and sheep were slaughtered before the eyes of the Navajo and left to decay where they had fallen, polluting the water of the area and befouling the air for miles around. This was a lesson in economy which had only recently been introduced (1933) to the white man and one which the Indian could in no wise understand. Sheep and goats were basic to the Navajo culture; Navajo have always looked to them for their subsistence. Even though thousands of animals were not fit for human consumption; to the Navajo, shooting them and leaving them to rot was nothing less than barbarism and an inexcusable waste.

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[5] Harry Williams, Interview by the present writer, August 31, 1940.

[6] Tseche Notah, Interview by the present writer, October 19, 1940.

[7] **Survey of Conditions of the Indians of the United States,** Part 34, (Washington, D. C.: United States Printing Office, 1937), p. 17988.

The whole reduction program had brought discontentment, bewilderment, and fear to the Navajo; but the shooting of the goats created a worse effect. This caused many to turn from their bewilderment and fear to a spirit of utter defiance and hate. They defied the government agents to injure them any more, developed an intense hatred for Mr. Collier, and became non-cooperative with the government agents.

> We have always had a lot of confidence in the government people, and felt that what they did would be for our own good because it had always been that way. At first we tried to meet the government half-way, but in the last few years we have felt that the government people aren't our friends so now we don't want to meet them halfway . . . We have reached the place where we have no confidence in the government people, nor any hope for the future. How can we have? We do not see what we can do to get any help, nor will they let us help ourselves. We don't even know what the government wants us to do.[8]

The Navajo problem is national in scope. It is an intricate combination of three intertwining problems, including (1) the national conservation problem; (2) the Indian Service's problem of administering the conservation program on the Navajo Reservation; and (3) the crisis which faces the Navajo Indian as a result of the deterioration of his grazing lands, which makes it necessary for him to adjust his cultural pattern and social values to the methods of procedure in the administration's conservation program.

In the case of the Navajo the very core of Navajo culture is of an economic nature, based on a pastoral industry, and as such under present conditions that which is so fundamental to these Indians' cultural values has become comparatively unstable. Thus the Navajo's feeling of uneasiness and fear has resulted from the reality of a threat to their economic security which is basic to their cultural scheme.

The Navajo are in a period of cultural disintegration. Many of the values of their old civilization have been destroyed, and the new values which they will be forced to accept have not yet taken root. They are in a period of transition which is coupled with a general state of uneasiness and discontentment. It will take years to make the proper adjustment to this new situation. In the meantime the Navajo are discouraged, upset, and many have developed an attitude of "What's the use?" Thus they are in a state of disorganization, which is being exemplified in the process of degeneration and decadence that is affecting the structure of Navajo society. The Navajo's culture patterns are so closely related to their land, which is fundamental to their pastoral economy, that when the range could no longer support the rapidly increasing number of sheep, goats, and horses, and the Federal Government was forced to take drastic action by inaugurating a stock reduction program, the Indian's cultural patterns were disrupted.

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[8] Harry Thomas, Interview by the present writer, October 18, 1940.

All this gives rise to an extremely difficult human problem. The Navajo are psychologically different from the white man in their reactions to social and economic adjustment. Since they are ultraconservative, they become bewildered and restless when social and economic pressure is forced upon them. There is a deep underlying psychological reaction on the part of the Navajo to the ever increasing pressure and infiltration of the white man's social and economic influence. They are going through a period of social and economic change which in their present status will continue for many years.

The process of culture breakdown is at work among the Navajo. Certain pressures are forcing a change in their customs and their ideals; hence, unless they are aided in making a proper adjustment, their whole social structure will crumble. There will no longer be any meaning to life since all the old goals and ambitions will be gone. Laws may be passed and regulations may be made to control and guide the Navajo in certain channels, but these will be mere words unless they make sense to the people.

Proper guidance can save the basic elements of Navajo culture, but if they are permitted to lose hold of their culture and are not directed in channels which will enable them to achieve a new cultural integration, they will go through a stage of personal and moral disintegration. The government program stresses physical and economic survival, which are pre-conditions essential to culture integration, but the Indian Service must bear in mind that they are not all of it. Culture goes deeper than its tangible elements; therefore, there must be a non-material structure of ideas, of values, attitudes, symbols, and beliefs. When the group's old values and attitudes are lost and there are no new ones to take their place, the people perish.

The Navajo's basic economy and therefore his cultural patterns are at stake, but his type of economy is in conflict with our economy. In the final analysis the Federal Government is obligated to preserve both the Navajo's and the white man's economy, and at the same time save the spirit of the Navajo Indian. If this task is to be accomplished, forces must be brought into action which will assure a program based on well-planned social engineering.

Certain sociological findings of possible importance which might be drawn from this study are as follows:

1. When one culture is imposed by a dominant group upon a minority group, the latter naturally reacts adversely. Cultural change

comes slowly because of the difficulty of any individual or group to accept new ideas, and the inability of the members of one culture to appreciate the utility of another culture.

2. There is a tendency on the part of the majority group to approach the minority group's problem on the basis of blanket surveys which determine blanket policies and programs. Under such an arrangement attention is centered on the group and little consideration is given to the individual in the solving of his personal problems.

3. When it is necessary for the majority group to make a modification of the minority group's culture, the representatives of the majority must start with the minority group's cultural patterns and social values as a base and patiently work from that point toward the desired goal be it social or economic.

4. When one culture group becomes subjected to the rules of another culture group, a "discipline complex" tends to displace native control. When this happens, the subjected group is forced to follow the discipline and regulations fashioned after the majority group's cultural patterns, which call for the substitution of new habits for the minority group's old ones. Since the subject group is committed to social-cultural valuations, its own cultural disintegration will probably follow.

5. The specialization and limitation of a group's economy tends to become definitely associated with fixed cultural patterns, values, and attitudes. Consequently, their economic stability undermined, they tend to become disorganized. Therefore, the acculturation process calls for wise planning with special reference to the necessary economic and social readjustment that a subject group must undergo.

6. There is a tendency on the part of the majority group to give little attention to the minority group until the minority group shows signs of cultural disintegration. Then the majority group becomes aware of the minority group's state of disorganization and for its own protection is forced to assume the burden of a rehabilitation program.

7. As a rule, new social developments come slowly, and in due time a culture may make some definite changes without any break in the continuity, but a sudden introduction of a new element into a culture which strikes at the core of that culture makes it difficult for the affected society to maintain its integrity and a serious disruption is likely to follow. In other words, the application of a new culture to an old culture cannot successfully take place within a few years but calls for telic long term planning.

8. In modern America it is no longer possible for a minority group to retain its old cultural patterns by remaining isolated from the majority group. There is an ever increasing pressure and infiltration of the white man's social and economic influence. The minority groups are slowly but surely being engulfed by the continual pressure of modern American culture.

# SECTION IV: THE EARTH SCIENCES

GEOGRAPHY AND GEOLOGY OF THE NEAR EAST OIL FIELDS. JOHN MURRELL, Dallas, Texas. No abstract received.

A KONINCKIOCERAS FORM THE LOWER PERMIAN OF NORTH CENTRAL TEXAS. AUGUSTA HASSLOCK KEMP, Seymour, Texas. No abstract received.

THE ISTHMUS OF TEHUANTEPEC, A BRIDGE BETWEEN THE OCEANS, PAUL WEAVER, Houston, Texas. No abstract received.

A TRIP THROUGH MEXICO. Sound movie in technicolor by courtesy of Gulf Oil Corporation, Houston.

# SECTION V: CONSERVATION

## A STUDY OF THE CARRYING CAPACITY OF A RANGE

By

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In my former position as Grazing Research Botanist of the Texas Agricultural Experiment Station, I participated in a project started in 1924 to study the amount of forage produced on the range and of its utilization by livestock. The work was carried out at the Ranch Experiment Station, or Texas Substation No. 14, which is located on the Edwards Plateau about midway between Sonora and Rocksprings. This test was conducted for a full period of five years, ending the first of the year 1929.

Years previous to this period the chemical and physiological principles of animal nutrition had been worked out as to the maintenance and gain requirements of the classes of livestock, whereby the dry matter consumption of an individual animal or group of animals may be computed. With this as a start the amount of forage utilized on the range may be ascertained.

In this test complete and detailed records were kept for six of the larger pastures to show definite numbers, weights, dates, and classification for all the animals grazing therein. In order to avoid supplementary feeding and other circumstances which would have complicated the problem seriously, such data were not taken for the smaller pastures.

In these six pastures, comprising 4.91 sections, three types of livestock, cattle, sheep, and goats, were grazed, and frequently with all three types present in a pasture at the same time. Each of these types consisted of a few or more classes. For example, the classes of cattle included that of mother cows, dry cows, 2-year heifers, yearling heifers, calves, bulls, yearling steers, and 2-year steers, or eight classes in all.

Regular weighing dates came at approximately 10-week intervals each year, the operations taking about a week each time. In addition counts and weights were always taken for any and all transfers, including accidental losses or gains as from death or strays. Various individual weights were taken from time to time, including the beginning and the ending of the breeding season, the birth weights of all calves, the mother being weighed the same day, and the birth weights of lambs and kids from the registered flocks, the mothers also being weighed the same day. All animals were numbered, the young receiving this designation on their birthday, so all records could be kept properly. At the time of taking individual weights it was customary to also make a pasture transfer. All young cattle were weighed individually every six weeks as required in another project; but these weights became part of our data. Sick animals, when noted, were weighed out of the pasture, so deaths in the pasture were at a minimum. Pastures were ridden closely, frequently daily, and carcasses were found promptly, identified, and record made of the loss. Thus, every effort was made to gain for our data an approximation to accuracy for the two variable factors concerned; that is, the number of grazing days for each class of livestock, and the average weight for the period involved.

Two other factors are involved in the formula for computing the dry matter consumption of a particular group of livestock on the range, in separate operations for their maintenance on the one hand and on the other hand for their gain in pounds of live weight, provided such gains have been made. One of these factors is the therm, which is a heat unit, and is the amount of heat required to raise one gram of water one degree centigrade. The therm is used to measure the productive value of range forage, inasmuch as so many therms to the pound of live weight is required by animals for their maintenance and, additionally, in case of a gain, so many therms are required for the gain of one pound in live weight, varying in amount with the age of the animal. The other factor employed is that of the dry matter equivalent, which is used to express the productive value of range forage. The State Chemist, Dr. G. S. Fraps, estimated that range forage has a productive value of 35 therms in 100 pounds of dry matter, and this may be stated that one therm is produced by eating 2.86 pounds of dry matter as represented by range forage.

The mathematical formula used for computing the forage consumption of livestock as expressed in dry matter, is as follows: total grazing days x average weight, x therms required per pound x the dry matter equivalent. With the four factors of this formula replaced by the appropriate figures a single operation gives the pounds of forage, expressed as dry matter, consumed by a particular class of livestock for a particular period. Where a gain in live weight has been made a separate and distinct operation is required. When good forage is plentiful much of it is used in the production of gains, and when the forage is inadequate there are losses in live weights instead of gains. In both mathematical operations another step is necessary for converting the dry matter consumption into carrying capacity units. In our case this means dividing the pounds of dry matter consumed by 7634, which is the annual forage consmption, expressed in pounds of dry matter, by the average mature cow on our range. In this manner was worked out the carrying capacity units used by each class of livestock in each pasture for each month throughout the five years of the test. The computations were made on a scale ample to show the presence of an individual animal in a pasture for a single day.

For the five-year period the average weight of the mature cow was 893 pounds, of the average ewe, 107 pounds, and of the average doe, 67 pounds. With the annual dry matter consumption of the average mature cow expressed as unity, the average consumption of the average ewe is .16, and the annual consumption of the average doe is .11. With us then, this is to say that 6¼ ewes or 9 1/11 does, will consume as much forage as a cow, or to state it differently, a mature cow consumes a little more forage on the range than do six sheep or nine goats.

When more than one type of livestock is grazed on a range, then suitable allowance should be made for the forage consumption of each type. The range should have a higher carrying capacity when the three types of livestock are grazed thereon; but this increase usually has been overestimated grossly. Sometimes a range has been stocked with enough sheep to care for its entire forage production, but in addition to the sheep both cattle and goats were being grazed thereon. What happens then is expressed in the language of the ranching country, "they have sand-papered that pasture." Little more than the trees and the rocks remain, except that in recent years over much of the area there remains also considerable poisonous herbaceous vegetation.

In the five-year period our range production was utilized approximately to the extent of 44 per cent by cattle, 37 per cent by sheep, and 19 per cent by goats. Because of variable range conditions there is little to be said about the proper proportion of types of livestock for the emost effective utilization of the forage produced. It is likely that the appropriate proportion of types of livestock may vary from time to time in order to correspond with the changes taking place on the range, and thus is subject to the judgment of the operator.

The event leading up to the formulation of our project for studying the carrying capacity of a range was that of the publication of Texas Agricultural Experiment Station Bulletin No. 297, "An Economic Study of a Typical Ranching Area on the Edwards Plateau of Texas," in which a chapter was devoted to "The Carrying Capacities of the Ranges." In this chapter the authors, Youngblood and Cox, reported for the month of August, 1920, the number of cattle, sheep, and goats for 97 ranches in Sutton County, and, in this connection, assembled data, very largely estimates, which resulted in their formulation of a carrying capacity unit represented by a dry matter consumption annually of 5591 pounds. This was computed from an estimation that the average cow weighed 750 pounds and that she gained 75 pounds in live weight during the year. But estimates are not facts, so we proceeded to get facts.

With definite data the first two years of our work, in which the results were approximately the same, showed that our average mature cow weighed nearly 150 pounds more and that her annual dry matter consumption amounted to 7634 pounds or an excess of 2043 pounds over the 5591 pounds derived by Youngblood and Cox from estimates. Furthermore Youngblood and Cox figured that the average stocking of the ranches of Sutton County was 70 of their units. Our data revealed that we were stocked at approximately 70 of our considerably larger unit. In the former case there was involved the production and the consumption of range forage, expressed as dry matter, of approximately 391,000 pounds, or 195½ tons, to the section, while in our case the comparable figures were 534,000 pounds, or 267 tons, or a difference of 143,000 pounds, or 71½ tons to the section. At least some of the Sutton County ranches were stocked heavier than we were, and like ours showed serious range deterioration.

Using the annual consumption of 7634 pounds of forage, expressed as dry matter, as unity, our records show the average annual stocking for the five years of the test to be as follows:

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|---|---|
| for the year of 1924, | 76 units, |
| for the year of 1925, | 62 units, |
| for the year of 1926, | 50 units, |
| for the year of 1927, | 66 units, and |
| for the year of 1928, | 78 units, |

Thus the average rate of stocking for the five years was 66 units to the section, with the first and the last year both exceeding 70 units. The divergence from the poorest year, 1926 with 50 units to the section, and the best year, 1928 with 78 units to the section, is 28 units. These figures largely express the difference in forage production of the range from year to year, for the number of animals was more or less the same throughout. The figures also show that by far too many animals were on the range in 1926 to harvest the 50 units of forage production. This circumstance was hard on livestock, hard on their owner, and doubly hard on the range. If the livestock are too numerous on the range for the feed it provides then the weights, the gains, the crop production, the death losses, unless checked by supplementary feeding, of the livestock concerned will give evidence of the fact.

At the beginning of this test the range already was in a state of serious deterioration, and this state persisted and even increased throughout the period of the test. Not at the beginning nor at the end of the test, and not altogether since then and on up to the present time has the seriousness of the situation or its vast economic significance been grasped by some, or by most of us, who have been concerned in this problem. Subsequent to the conclusion of this test it was deemed possible that the estimated forage production of the range as derived by Youngblood and Cox of 195½ tons annually of dry matter to the section was more nearly the capacity of our range. This could be accomplished by reducing our rate of stocking to 51 of our units. Hence a standard of stocking was prepared that allowed for 52 such units to the section, or for a forage production of 198½ tons annually of dry matter to the section. As detailed figures are not available for this subsequent period, we can only say that the effort was made to stock at approximately this rate. This marked reduction in the rate of stocking has brought noticeable improvement in the condition of the range; but nothing about which to get excited. The range is better than it was, of course, but its condition still is poor indeed. At the present time another step in the process of rehabilitation of our range is being planned. This step may be deemed to be radical, for it calls for a rate of stocking with 35 units, or for an annual forage production, expressed as dry matter, of 133½ tons to the section. Still, it is possible that this proposed reduction is not radical enough. I would feel more hopeful of quicker and better results could the rate of stocking be set at 25 units to the section, which would provide for a forage consumption annually to the section of 95½ tons of dry matter. Or the standard could be set at 26 units to the section to provide for a forage consumption of 100 tons of dry matter annually to the section. If this could be done, I think that one result would soon become noticeable, and this would be for our mature cows to begin to weigh more, thus increasing the size of our carrying capacity unit. We know of ranges in Texas where the mature cows on the average weigh as much as one or two hundred pounds more than do our cows; and we strongly feel that our range could be restored and so managed that our cows would weigh as much as theirs, if not more, and thereby to increase markedly the size of our carrying capacity unit. This is to say that the improved range brought about largely by the reduced rate of stocking with livestock will result in an increase of the size of the carrying capacity unit, and this most assuredly would indicate a more efficient and more profitable management of the ranching business. With the range producing properly and its crop harvested the result will be more beef, more wool, more mohair, produced to the section with fewer animals and with less expense. The more or less prevalent idea that every blade of grass, not consumed by livestock is wasted is an erroneous one, and it should be combatted by spreading the knowledge that the range, as it now exists, is capable of great improvement and thereafter can be maintained at a high rate of production, and that this may be accomplished with substantial profit to all concerned. For many years now, perhaps thirty or more, most ranchmen have been working against Nature, and the result has been expensive and rather disastrous; if man will not reduce his rate of stocking with livestock, then Nature, as she has been doing and is doing now, will attend to the matter for him, and at his great cost.

## RESERVOIR CONTROL—AS PRACTICED IN SOME TEXAS OIL FIELDS

BY

ERNEST O. THOMPSON—RAILROAD COMMISSIONER

TO BE DELIVERED

THE TEXAS ACADEMY OF SCIENCE MEETING

DALLAS, TEXAS, DECEMBER 13, 1946

It has been only within the last decade that oil producers have come to the realization that reservoir control is possible, and they have found it to be to their very decided economic interest.

Formerly oil producers felt that any reduction or interference in the rate of flow of an oil well would permanently injure the well and reduce the well's ultimate recovery. Now they know that it is good practice to control production at the optimum rate.

Also in the old days—even as late as the 20's some discoverers of gas wells had the belief that if you would let the gas well blow the oil might be attracted to the well's bore and make an oil well.

We have learned a lot about producing oil in the last twenty years.

The science of petroleum engineering has become of age in this present generation. This science has made a place for itself and has contributed greatly to our national security in war and has added to our national and international economy in peace.

Odd as it may seem it took a deluge of oil to make us come to our senses and bring true conservation of reservoir energy into enforced practice. The law had to be written on the books by our legislature and the courts worked it over again and again.

When the East Texas Oil Field was brought in and its size fairly realized by the industry there was at that time (1933) a recognized market demand for Texas crude oil in the amount of 740,000 barrels per day.

The East Texas Field was producing up to 900,000 barrels per day. Oil has dropped in price from the high of $3.50 per barrel during the 20's to ten cents a barrel. Chaos reigned in the oil markets of the world.

The oil industry was in a dither. They were drowning in a deluge of oil. Control of production had to come to a hitherto wildcat industry. Something had to be done to stabilize the oil producing industry.

Science came to the rescue.

The Texas Railroad Commission was given the duty of prescribing rules and regulations and enforcing them under statute in order to prevent physical waste in the producing and storing of oil and gas.

The first thing we did was to engage a staff of young petroleum engineers just out of college. Then we ordered the entire oil field shut in for the purpose of taking bottom hole reservoir pressures.

We kept the field shut in for 21 days and observed that the reservoir pressure increased fourteen pounds while shut in.

Then we allowed the field to reopen at a greatly reduced allowable production rate per day.

Our idea was that a slower rate of withdrawal would assist nature in maintaining the reservoir pressure.

We again shut in the entire field after two months operation and found a fourteen pound pressure increase during the 21 day shut down.

Thus we were able to show the courts when our orders were attacked that there was a direct relationship between the rate of withdrawal of oil and water and gas and the bottom hole pressure in the reservoir.

Thus we were able to convince the courts that we were actually conserving and preventing the waste of reservoir pressure in that field. The idea was that the better we conserved the reservoir pressure the more oil would be lifted to the service of the earth for the use of mankind.

The pressure of the East Texas field is created by water encroachment from the West coming in contact with the oil saturated sand in the field.

We then decided to require the reinjection of the salt water produced with the oil to further assist nature. Today we are successfully reinjecting 466,850 barrels daily or 91.57% of the total water produced.

Attached hereto is the latest report of the salt water injection project.

The results are most satisfactory.

Experts at first estimated that the total ultimate recovery of the East Texas Field would be in the amount of one billion barrels of oil.

However under our scientific plan of operation and reservoir pressure control we have already produced and saved two billion three hundred million barrels of oil and the same experts now predict we will recover three more billions of barrels of oil making a total of over five billion barrels of oil where only one billion was expected to be recovered under older production methods of wider open flow. This is a dividend of four billions barrels of oil on the use of scientific reservoir control.

I believe it is the world's best example of combining a secondary flushing of the sand with the primary flowing operation.

We are daily producing 326,000 barrels of oil from this field and have done so every day this year yet the reservoir pressure (1.63) one and sixty-three hundreds pounds higher than it was on January 1, 1946. Thus it would seem we have just about achieved reservoir pressure control in this field.

## RAILROAD COMMISSION OF TEXAS

**Oil and Gas Division** **Engineering Department**

### SUMMARY SHOWING TOTAL ALLOWABLES AND STATUS OF WELLS IN THE EAST TEXAS FIELD FOR THE MONTH OF NOVEMBER, 1946

| Date | No. Wells | New Wells | Wells P. &. A. | Wells | | Total Off Prod. | Marg. Wells | Marginal Allowable | Total Field Allowable |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Off Prod. | Rein-Stated | | | | |
| | 23,465 | | | | | 374 | 1504 | 13,191.12 | 463,736.88 |
| R.A. | 23,460 | 3 | 8 | 1 | 1 | 366 | 1512 | 13,294.56 | 463,716.77 |
| 1 | 23,459 | 1 | 2 | 15 | 1 | 378 | 1503 | 13,146.29 | 461,369.38 |
| 2 | 23,457 | | 2 | 1 | | 377 | 1502 | 13,140.29 | 461,363.38 |
| 3 | 23,457 | | | | | 377 | 1503 | 13,159.36 | 461,362.45 |
| 4 | 23,457 | | | | | 377 | 1503 | 13,176.48 | 461,379.57 |
| 5 | 23,457 | | | | | 377 | 1502 | 13,166.60 | 461,389.69 |
| 6 | 23,457 | | | | | 377 | 1502 | 13,162.11 | 461,385.20 |
| 7 | 23,456 | 1 | 2 | 1 | | 376 | 1502 | 13,174.08 | 461,397.17 |
| 8 | 23,454 | | 2 | | | 374 | 1502 | 13,174.08 | 461,397.17 |
| 9 | 23,451 | | 3 | 2 | | 373 | 1500 | 13,158.78 | 461,381.87 |
| 10 | 23,451 | | | | | 373 | 1500 | 13,158.78 | 461,381.87 |
| 11 | 23,451 | | | | | 373 | 1500 | 13,158.78 | 461,381.87 |
| 12 | 23,446 | | 5 | 4 | | 372 | 1496 | 13,136.49 | 461,339.58 |
| 13 | 23,446 | | | | | 372 | 1496 | 13,136.49 | 461,386.00 |
| 14 | 23,445 | | 1 | | | 371 | 1496 | 13,136.49 | 461,386.00 |
| 15 | 23,442 | | 3 | 2 | 1 | 369 | 1501 | 13,172.12 | 461,321.63 |
| 16 | 23,441 | | 1 | 2 | 1 | 369 | 1501 | 13,172.12 | 461,303.67 |
| 17 | 23,441 | | | | | 369 | 1501 | 13,172.12 | 461,303.67 |
| 18 | 23,440 | | 1 | | | 368 | 1501 | 13,172.12 | 461,303.67 |
| 19 | 23,438 | | 2 | | | 366 | 1501 | 13,172.12 | 461,303.67 |
| 20 | 23,436 | | 2 | | | 364 | 1501 | 13,172.12 | 461,303.67 |
| 21 | 23,436 | | | | | 364 | 1501 | 13,172.12 | 461,303.67 |
| 22 | 23,433 | 1 | 4 | 2 | | 362 | 1500 | 13,170.12 | 461,301.67 |
| 23 | 23,432 | | 1 | 1 | | 362 | 1499 | 13,159.87 | 461,291.42 |
| 24 | 23,432 | | | | | 362 | 1499 | 13,159.87 | 461,291.42 |
| 25 | 23,431 | | 1 | 1 | | 362 | 1499 | 13,159.87 | 461,271.42 |
| 26 | 23,429 | | 2 | 1 | 1 | 360 | 1499 | 13,159.87 | 461,271.42 |
| 27 | 23,428 | | 1 | | | 359 | 1499 | 13,159.87 | 461,271.42 |
| 28 | 23,427 | | 1 | | | 358 | 1499 | 13,159.87 | 461,271.42 |
| 29 | 23,427 | | | | | 358 | 1499 | 13,159.87 | 461,271.42 |
| 30 | 23,427 | | | | | 358 | 1499 | 13,159.87 | 461,271.42 |
| | | 6 | 44 | 33 | 5 | –16 | –5 | –31.25 | 9,806,421.90 |

Average Daily Allowable.............................326,880.73
On 21 Unspecified Producing Days Each Month.

Kilgore, Texas
December 4, 1946

## PROGRESS REPORT

## EAST TEXAS SALT WATER DISPOSAL COMPANY

### MONTH OF NOVEMBER 1946

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**Summary for the month of November 1946**

| | | | |
|---|---|---|---|
| 1. | Injected by Salt Water Co. | 9,759,781 bbls. | — 325,326 B/D |
| 2. | Injected by others (Est.) | 3,645,733 bbls. | — 121,524 B/D |
| 3. | Total injected | 13,405,514 bbls. | — 446,850 B/D |
| 4. | Water produced (Est.) | 14,640,000 bbls. | — 488,000 B/D |
| 5. | Percent injected | 91.57% | |
| 6. | Oil produced (Est.) | 9,726,960 bbls. | — 324,232 B/D |

7. Total fluid produced: Daily average 898,420 bbls.
8. Net fluid withdrawal: Daily average 451,570 bbls.
9. Bottom hole pressure Nov. 1, 1946: 1017.78 lbs. per sq. inch
10. New wells completed: None

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During the month of November 1946, the East Texas Salt Water Disposal Company injected a total of 9,759,781 barrels of salt water which is a daily average of 325,326 barrels. The injection for the past several months has been as follows:

| Month | Daily Average | Daily Average Change |
|---|---|---|
| | (bbls) | (bbls) |
| September | 316,107 | 10,410 |
| October | 327,117 | 11,010 |
| November | 325,326 | –1,791 |

The daily average volume of water injected for November 1946 was 1791 barrels less than for the month of October 1946. The volume of water produced did not decrease, but serious difficulties at several systems made it impossible to handle all of the water available. The Everett System was shut down for several days due to high water in the Sabine River bottom. In the south end of the field, an electrical storm during the first part of the month not only burned out transformers and motors of the Salt Water Company, but likewise seriously interferred with the production schedules of many of the oil operators. Notwithstanding these difficulties, the usual full capacity of the plants was utilized during the last half of the month.

Arrangements were made during November 1946 to utilize the excess capacity in the Sinclair-Wright system. During the month, 56,128 barrels of water were injected into this well for the account of the Salt Water Company.

The need for a new system north of the present Nicholson system and also a new plant and well west of the Shaw system was called to the attention of the Executive Committee at its meeting in Dallas on November 26, 1946. These conditions had been previously reported, but inasmuch as there was not a quorum present at the Executive Committee meeting no definite action could be taken on the proposals.

The Executive Committee approved a "Cost of Living Wage Bonus" for the last ten weeks of 1946 of one regular forty hour work week payment to each employee on the payroll as of October 22, 1946. This bonus will be offered to employees covered by the Union Contract and will be paid to all other employees, except officers and directors, with the December 16, 1946 pay checks.

All of the bonus oil tendered to the Salt Water Company has been assigned to the following companies for the three month period.

| **Bonus Oil Producer** | **September** | **October** | **November** |
|---|---|---|---|
| Arkansas | 8,698.12 | 8,184.96 | 5,551.06 |
| Atlantic | 9,136.04 | 9,363.64 | 7,933.73 |
| General Crude | 5,060.60 | 5,009.90 | 4,056.92 |
| Humble | 9,576.10 | 9,766.50 | 8,183.19 |
| Magnolia | 7,827.88 | 8,440.76 | 5,230.72 |
| Shell | 2,461.74 | 2,101.70 | 1,903.71 |
| Smith, R. E. | 4,885.74 | 4,496.08 | 3,226.88 |
| Stanolind | 9,447.62 | 9,823.76 | 7,854.05 |
| Sun | 3,730.16 | 3,634.16 | 4,600.77 |
| Superior | 2,028.60 | 2,051.90 | 1,709.92 |
| Tide Water | 2,893.84 | 2,952.30 | 2,874.46 |
| Total | 65,746.44 | 65,825.66 | 53,125.41 |

The average reservoir pressure as of November 1, 1946 was 1017.78 psi which was an increase of 4.28 pounds during the month of October 1946. On November 1, 1946 the average pressure was 1.63 psi higher than on January 1, 1946.

Tabulation 1—Month of November 1946

## EAST TEXAS SALT WATER DISPOSAL COMPANY

| **A.** | **Injection Systems** | **Wells Served** | **November 1946 Total Month** | **Injection - Bbls Daily Average** |
|---|---|---|---|---|
| 1. | M. Albertson | 110 | 256,172 | 8,539 |
| 2. | Tom Bell | 25 | 148,940 | 4,965 |
| 3. | E. H. Blum | 157 | 260,930 | 8,698 |
| 4. | C. O. Christian | 63 | 287,510 | 9,584 |
| 5. | C. G. Condra | 42 | 374,465 | 12,482 |
| 6. | L. J. Everett | 114 | 352,220 | 11,741 |
| 7. | David Frame | 230 | 401,780 | 13,393 |
| 8 | Frame-Henson | ---- | Shut | Down |
| 9. | J. J. Frommer No. 1 | 107 | 332,525 | 11,084 |
| 10. | J. J. Frommer No. 2 | ---- | 351,055 | 11,702 |
| 11. | Gladney | 22 | 306,210 | 10,207 |
| 12. | R. E. Hardwicks | 101 | 322,010 | 10,734 |
| 13. | Hughes | 64 | 237,212 | 7,907 |
| 14. | W. B. Kee | 84 | 242,720 | 8,090 |
| 15. | J. S. King | 53 | 183,050 | 6,102 |
| 16. | J. A. Layne | 40 | 199,170 | 6,639 |
| 17. | W. S. Morris | 56 | 129,151 | 4,305 |
| 18. | J. H. Moyar | 62 | 387,070 | 12,902 |
| 19. | W. R. Nicholson | 89 | 157,600 | 5,253 |
| 20. | Larry O'Donnell | 74 | 409,210 | 13,640 |
| 21. | H. A. Pace "B" | 55 | 292,930 | 9,764 |
| 22. | Bryan W. Payne No. 1 | 281 | 323,866 | 10,796 |
| 23. | Bryan W. Payne No. 2 | ---- | 326,776 | 10,893 |
| 24. | Bryan W. Payne No. 3 | ---- | 265,688 | 8,856 |
| 25. | Jack Pew | 121 | 301,620 | 10,054 |
| 26. | T. C. Ramey | 32 | 179,429 | 5,981 |
| 27. | Walter Shaw | 126 | 334,920 | 11,164 |
| 28. | C. R. Starnes | 97 | 375,640 | 12,521 |
| 29. | John R. Suman | 159 | 247,503 | 8,250 |
| 30. | H. J. Thomas | 43 | 166,980 | 5,566 |
| 31. | A. L. Walker | 40 | 127,994 | 4,266 |
| 32. | B. E. Warren No. 1 | 69 | 32,009 | 1,067 |
| 33. | J. E. Warren | ---- | 186,447 | 6,215 |
| 34. | Joe Zeppa No. 1 | 549 | 204,130 | 6,804 |
| 35. | Joe Zeppa No. 2 | ---- | 257,412 | 8,580 |
| 36. | ZeppaICook No. 5 | ---- | 315,945 | 10,532 |
| 37 | Zeppa-Wolford No. 7 | ---- | 317,241 | 10,575 |
|  | Sub Total | 3,065 | 9,595,530 | 319,851 |
| **B.** | **Excess Capacity** |  |  |  |
| 1. | Sinclair-Cole | 15 | 30,055 | 1,002 |
| 2. | Sinclair-Jarvis | 0 | 47,096 | 1,570 |
| 3. | Sinclair-Tipps | 14 | 3,162 | 105 |
| 4. | Sinclair-Wilson | 5 | 27,810 | 927 |
| 5. | Sinclair-Wright | 10 | 56,128 | 1,871 |
|  | Sub Total | 44 | 164,251 | 5,475 |
| TOTAL |  | 3,109 | 9,759,781 | 325,326 |

TAB. 2—SALT WATER INJECTED BY EAST TEXAS SALT WATER DISPOSAL COMPANY

| Month | Facilities Furnished | | Injection Wells | Water Injected—Barrels | | Net Cost Per Barrel (Before Taxes) |
|---|---|---|---|---|---|---|
| | Leases | Wells | | Month | Daily Average | |
| Total 1942 | | | | 588,607 | 6,398 | |
| Total 1943 | | | | 40,593,672 | 111,216 | 1.719c |
| Total 1944 | | | | 79,279,702 | 216,611 | 1.404 |
| **1945** | | | | | | |
| January | 456 | 2,424 | 34 | 6,948,606 | 224,149 | 1.353 |
| February | 446 | 2,419 | 33 | 6,456,108 | 230,575 | 1.360 |
| March | 448 | 2,451 | 33 | 7,175,638 | 231,472 | 1.358 |
| April | 447 | 2,456 | 33 | 6,922,225 | 230,741 | 1.417 |
| May | 452 | 2,493 | 33 | 7,447,162 | 240,231 | 1.286 |
| June | 461 | 2,529 | 33 | 7,373,260 | 245,775 | 1.336 |
| July | 459 | 2,523 | 32 | 7,785,453 | 251,144 | 1.343 |
| August | 462 | 2,542 | 32 | 7,859,747 | 253,540 | 1.298 |
| September | 464 | 2,674 | 34 | 7,331,835 | 244,395 | 1.486 |
| October | 466 | 2,707 | 33 | 7,605,289 | 245,332 | 1.652 |
| November | 479 | 2,766 | 35 | 7,513,388 | 250,446 | 1.455 |
| December | 480 | 2,776 | 34 | 7,848,522 | 253,178 | 1.780 |
| Total 1945 | | | | 88,267,231 | 241,828 | 1.429 |
| **1946** | | | | | | |
| January | 466 | 2,808 | 34 | 7,980,301 | 257,429 | 1.313 |
| February | 473 | 2,850 | 34 | 7,255,038 | 259,109 | 1.463 |
| March | 480 | 2,839 | 34 | 8,613,540 | 277,856 | 1.394 |
| April | 468 | 2,834 | 34 | 8,744,627 | 291,488 | 1.381 |
| May | 471 | 2,840 | 34 | 9,534,340 | 307,560 | 1.366 |
| June | 469 | 2,852 | 36 | 9,237,261 | 307,909 | 1.293 |
| July | 467 | 2,886 | 37 | 9,575,534 | 308,888 | 1.419 |
| August | 470 | 2,934 | 39 | 9,476,603 | 305,697 | 1.549 |
| September | 475 | 2,980 | 39 | 9,483,207 | 316,107 | 1.615 |
| October | 488 | 3,061 | 40 | 10,140,630 | 327,117 | 1.455 |
| November | 498 | 3,109 | 41 | 9,759,781 | 325,326 | 1.427 Est. |
| Total—11 months 1946 | | | | 99,800,862 | 298,805 | 1.427 Est. |

## TAB. 3—SALT WATER INJECTION—EAST TEXAS FIELD

| Month | Injected by SALT WATER Co. Total Bbls. | Daily Av. Bbls. | Per Cent % | Injected by OTHER Companies Total Bbls. | Daily Av. Bbls. | Per Cent % | Total Salt Water Injected Total Bbls. | Daily Avg. Bbls. |
|---|---|---|---|---|---|---|---|---|
| **1943** | 40,593,672 | 111,216 | 55.12 | 33,049,169 | 90,545 | 44.88 | 73,642,841 | 201,761 |
| **1944** | 79,279,702 | 216,611 | 63.87 | 44,856,400 | 122,558 | 36.13 | 124,136,102 | 339,169 |
| **1945** | | | | | | | | |
| January | 6,948,606 | 224,149 | 63.54 | 3,987.130 | 128,617 | 36.46 | 10,935,736 | 352,766 |
| February | 6,456,108 | 230,575 | 63.51 | 3,709,172 | 132,471 | 36.49 | 10,165,280 | 363,046 |
| March | 7,175,638 | 231,472 | 63.76 | 4,079,225 | 131,588 | 36.24 | 11,254,863 | 363,060 |
| April | 6,922,225 | 230,741 | 63.57 | 3,967,047 | 132,235 | 36.43 | 10,889,272 | 362,976 |
| May | 7,447,162 | 240,231 | 62.57 | 4,454,374 | 143,690 | 37.43 | 11,901,536 | 383,921 |
| June | 7,373,260 | 245,775 | 64.06 | 4,135,858 | 137,862 | 35.94 | 11,509,118 | 383,637 |
| July | 7,785,453 | 251,144 | 65.72 | 4,060,221 | 130,974 | 34.28 | 11,845,674 | 382,118 |
| August | 7,859,747 | 253,540 | 65.71 | 4,100,944 | 132,288 | 34.29 | 11,960,691 | 385,828 |
| September | 7,331,835 | 244,395 | 65.68 | 3,850,575 | 128,285 | 34.42 | 11,182,410 | 372,680 |
| October | 7,605,287 | 245,332 | 64.21 | 4,239,881 | 136,770 | 35.79 | 11,845,168 | 382,102 |
| November | 7,513,388 | 250,446 | 64.03 | 4,221,689 | 140,723 | 35.97 | 11,735,077 | 391,169 |
| December | 7,848,522 | 253,178 | 65.65 | 4,106,132 | 132,456 | 34.35 | 11,954,654 | 385,634 |
| Total | 88,267,231 | 241,828 | 64.34 | 48,912,248 | 134,006 | 35.66 | 137,179,479 | 375,834 |
| **1946** | | | | | | | | |
| January | 7,980,301 | 257,429 | 66.77 | 3,970,864 | 128,092 | 33.23 | 11,951,165 | 385,521 |
| February | 7,255,038 | 259,109 | 66.50 | 3,655,338 | 130,547 | 33.50 | 10,910,376 | 389,656 |
| March | 8,613,540 | 277,856 | 68.21 | 4,013,790 | 129,476 | 31.79 | 12,627,330 | 407,332 |
| April | 8,744,627 | 291,488 | 68.25 | 4,068,193 | 135,606 | 31.75 | 12,812,820 | 427,094 |
| May | 9,534,340 | 307,560 | 70.24 | 4,038,864 | 130,285 | 29.76 | 13,573,204 | 437,845 |
| June | 9,237,261 | 307,909 | 71.37 | 3,705,311 | 123,510 | 28.63 | 12,942,572 | 431,419 |
| July | 9,575,534 | 308,888 | 71.68 | 3,783,473 | 122,048 | 28.32 | 13,359,007 | 430,936 |
| August | 9,476,603 | 305,697 | 71.96 | 3,693,032 | 119,129 | 28.04 | 13,169,635 | 424,826 |
| September | 9,483,207 | 316,107 | 72.38 | 3,619,626 | 120,654 | 27.62 | 13,102,833 | 436,761 |
| October | 10,140,630 | 327,117 | 72.88 | 3,774,460 | 121,756 | 27.12 | 12,915,090 | 448,873 |
| November | 9,759,781 | 325,326 | 72.80 | 3,645,733 | 121,524 | 27.20 | 13,405,514 | 446,850 |
| Total | 99,800,862 | 298,805 | 70.40 | 41,968,684 | 125,655 | 29.60 | 141,769,546 | 424,460 |

TAB. 4—SALT WATER PRODUCED AND INJECTED—EAST TEXAS FIELD

| Month | Salt Water Produced Month Bbls. | Salt Water Produced Daily Average Bbls. | Salt Water Injected Month Bbls. | Salt Water Injected Daily Average Bbls. | Per Cent Injected % | Producing Days |
|---|---|---|---|---|---|---|
| **1943** | 145,503,540 | 398,640 | 73,642,841 | 201,761 | 50.61 | ---- |
| **1944** | 170,423,237 | 465,637 | 124,136,102 | 339,169 | 72.84 | ---- |
| **1945** | | | | | | |
| January | 15,500,000 | 500,000 | 10,935,736 | 352,766 | 70.55 | 25 |
| February | 14,140,000 | 505,000 | 10,165,280 | 363,046 | 71.89 | 23 |
| March | 15,717,000 | 507,000 | 11,254,863 | 363,060 | 71.61 | 25 |
| April | 15,270,000 | 509,000 | 10,870,225 | 362,341 | 71.19 | 24 |
| May | 15,810,000 | 510,000 | 11,901,536 | 383,921 | 75.28 | 25 |
| June | 15,360,000 | 512,000 | 11,509,118 | 383,637 | 74.93 | 24 |
| July | 15,550,000 | 500,000 | 11,845,674 | 382,118 | 76.42 | 25 |
| August | 14,725,000 | 475,000 | 11,960,691 | 385,828 | 82.09 | 25 |
| September | 13,500,000 | 450,000 | 11,182,410 | 372,478 | 82.77 | 20 |
| October | 13,640,000 | 440,000 | 11,845,168 | 382,102 | 86.84 | 20 |
| November | 13,350,000 | 445,000 | 11,735,077 | 391,169 | 87.90 | 20 |
| December | 13,640,000 | 440,000 | 11,954,654 | 385,634 | 87.64 | 20 |
| Total | 176,152,000 | 482,608 | 137,179,479 | 375,834 | 77.88 | ---- |
| **1946** | | | | | | |
| January | 14,415,000 | 450,000 | 11,951,165 | 385,521 | 82.91 | 21 |
| February | 13,076,000 | 450,000 | 10,910,376 | 389,656 | 86.59 | 19 |
| March | 14,105,000 | 455,000 | 12,627,330 | 407,332 | 89.52 | 21 |
| April | 15,000,000 | 500,000 | 12,812,820 | 427,094 | 85.42 | 24 |
| May | 16,120,000 | 520,000 | 13,573,204 | 437,204 | 84.08 | 26 |
| June | 14,100,000 | 470,000 | 12,942,572 | 431,419 | 91.79 | 21 |
| July | 14,477,000 | 467,000 | 13,359,007 | 430,935 | 92.28 | 21 |
| August | 14,570,000 | 470,000 | 13,169,635 | 424,826 | 90.39 | 21 |
| September | 14,460,000 | 482,000 | 13,102,833 | 436,761 | 90.61 | 21 |
| October | 14,756,000 | 476,000 | 13,915,090 | 448,873 | 94.30 | 21 |
| November | 14,640,000 | 488,000 | 13,405,514 | 446,850 | 91.57 | 21 |
| Total | 159,719,000 | 478,200 | 141,769,546 | 424,460 | 88.76 | ---- |

## TAB. 5—FLUID WITHDRAWALS AND RESERVOIR PRESSURE—EAST TEXAS FIELD

| Month | Daily Average Production—Barrels Oil (Tank) | Oil & Gas (Reservoir) | Salt Water | Total Fluid | Water Injected Per Day | Net Fluid Withdrawal Per Day | Reservoir Pressure 1st of Mo. No. Sq. Inch |
|---|---|---|---|---|---|---|---|
| **1943** | 128,568,647 | — | 145,503,540 | — | 73,642,841 | — | — 3.27 |
| Daily | 352,243 | 455,877 | 398,640 | 844,517 | 201,761 | 642,756 | — |
| **1944** | 134,768,033 | — | 170,423,237 | — | 124,136,102 | — | — 11.20 |
| Daily | 368,219 | 466,100 | 465,637 | 931,737 | 339,169 | 592,568 | — |
| **1945** | | | | | | | |
| January | 384,846 | 487,147 | 500,000 | 987,147 | 352,766 | 634,381 | 1001.24 |
| February | 391,878 | 496,048 | 505,000 | 1,001,048 | 363,046 | 638,002 | 994.84 |
| March | 383,595 | 485,563 | 507,000 | 992,563 | 363,060 | 629,503 | 998.19 |
| April | 380,385 | 481,500 | 509,000 | 990,500 | 362,341 | 628,159 | 1002.02 |
| May | 382,092 | 483,661 | 510,000 | 993,661 | 383,921 | 609,740 | 999.75 |
| June | 378,594 | 479,233 | 512,000 | 991,233 | 383,637 | 607,596 | 998.27 |
| July | 380,000 | 481,012 | 500,000 | 981,012 | 382,118 | 598,894 | 1003.79 |
| August | 379,326 | 480,160 | 475,000 | 955,160 | 385,828 | 569,332 | 1002.97 |
| September | 318,133 | 402,700 | 450,000 | 852,700 | 372,680 | 480,020 | 1004.03 |
| October | 308,095 | 389,994 | 440,000 | 829,994 | 382,102 | 447,892 | No test |
| November | 316,728 | 400,922 | 445,000 | 845,922 | 391,168 | 454,754 | 1013.58 |
| December | 306,754 | 388,296 | 440,000 | 828,296 | 385,634 | 442,662 | 1012.65 |
| Total | 131,021,969 | — | 176,152,000 | — | 137,179,479 | — | 14.91 |
| Daily | 358,964 | 454,385 | 482,608 | 936,993 | 375,834 | 561,159 | — |
| **1946** | | | | | | | |
| January | 320,200 | 405,316 | 450,000 | 855,316 | 385,521 | 469,795 | 1016.15 |
| February | 321,009 | 406,341 | 450,000 | 856,341 | 389,656 | 466,685 | 1015.71 |
| March | 319,065 | 403,880 | 455,000 | 858,880 | 407,332 | 451,548 | 1015.34 |
| April | 371,900 | 470,760 | 500,000 | 970,760 | 427,094 | 543,666 | 1015.85 |
| May | 388,286 | 401,501 | 520,000 | 1,011,501 | 437,204 | 574,297 | 1011.34 |
| June | 326,496 | 413,289 | 470,000 | 883,289 | 431,419 | 451,870 | 1001.16 |
| July | 317,827 | 402,313 | 467,000 | 869,313 | 430,935 | 438,378 | 1005.46 |
| August | 317,313 | 401,662 | 470,000 | 871,662 | 424,826 | 446,836 | 1013.86 |
| September | 326,208 | 412,922 | 482,000 | 894,922 | 436,761 | 458,161 | 1012.31 |
| October | 316,424 | 400,536 | 476,000 | 876,536 | 448,873 | 427,663 | 1013.50 |
| November | 324,232 | 410,420 | 488,000 | 898,420 | 446,850 | 451,570 | 1017.78 |
| Average | 331,754 | 419,942 | 478,200 | 898,142 | 424,460 | 473,682 | — |

In many other fields we are successfully reinjecting gas produced with the oil so that the reservoir pressure may be maintained and greatly increase the total ultimate yield of oil from these fields.

Classic examples are Lake Creek, and Stratten Field Orders.

In a short time I predict there will be no oil field flares in Texas except in isolated wells. We are going to require that the gas be returned to the reservoir or utilize it for fuel.

Texas Academy of Science
Conservation Section
Dallas, Texas
December 12, 13, 1946

## WATER—TEXAS' PRESUMED NATURAL RESOURCE

by

Trigg Twichell
Hydraulic Engineer
United States Geological Survey

All too often, the general public appears to presume that water, our most valuable natural resource, is inexhaustible. Also, in many instances, little objection is made to the pollution of domestic water supplies by sewage effluent. The engineering profession possibly may be blamed for these errors, although designing and maintenance engineers have usually provided ample water of good quality to urban areas at a reasonable cost. The individual living in a typical Texas city needs an average of about 100 gallons, or about 830 pounds, of water daily. The demand varies greatly. In the cool winter months, his requirement is low but for a hot summer drought, he wants 200 or more gallons of water each day for his personal comfort and other domestic uses.

Industrial plants, irrigation farmers, and other water users also have a wide variety of fluctuating demands for water of varying quantities, qualities, and temperatures. The professional engineer usually meets the fluctuating public demands for domestic water without fanfare, and the individual receives the needed water at an average cost of about 5 cents a day, or less than his bus fare to town. The convenient manner in which the greater portion of our urban population has been supplied with the necessary domestic water has, in all probability, left the general impression that an ample water supply for all uses is not a great problem.

The farmer is not like the urban individual. He has learned through experience that rainfall does not always occur at the proper time to mature a crop. Even in humid east Texas, crop failures do occur from lack of rainfall. This was true in 1939 and again in 1946. In west Texas, the progressive dry-land farmer has learned to conserve moisture in the soil and thereby produce a fair crop even in drought years. Farmers, therefore, were among the first to fully realize the importance of water conservation. The farmer living on the top of a hill has learned, like those living on a river flood plain, that uncontrolled flood water can exert a destructive force. The floor of the Gulf of Mexico along the Texas coast is composed of soil washed from farms in all portions of the State—yes, even some of the fertile soil of the Texas Panhandle has gone into the sea. Improper farming methods, over-grazing of ranch lands, denuding forests without corrective measures, all these accelerate the sheet flows of surface water as it moves from the hillsides into defined water channels. The increased velocities, in turn, increase the silt load capacity of sheet flows. The users of the soil have been slow to realize that lost soil is lost capital, yet many thousand acres of Texas' fertile farmland have been reduced to non-productiveness by the destructive force of our circulating water resource. The force of flowing water, like that of atomic energy, can be destructive if not channeled to the proper uses of man. Through more intelligent basin-wide planning and building, flood flows can be controlled and utilized to a considerable extent from the time the raindrop falls on the land until it moves out of the river mouth to the sea. With controlled land operation, the acceleration of sheet flows across the land will be reduced. These operations help to retain the soil in place and aid in increasing soil moisture. As the surplus water moves into defined channels, it can be impounded and utilized to maintain uniform river flows through drought periods, to provide storage for municipal and industrial uses, reduce flood hazards, and where feasible, to produce electrical energy and supply water for navigation purposes, as well as for other uses.

Within the past five years, industrial plants costing more than one billion dollars have been erected in Texas. Synthetic rubber, magnesium, nylon, paper, steel, furniture, food products, airplanes, various chemicals, and many other products are now produced in quantity. About 700,000 acres of land have been provided with irrigation water for the first time in the same period, thereby expanding Texas' irrigated acreage to 2,400,000 acres in 1946. The earned income of the benefitted farmer and of his community has increased because of this improved method of watering his crops. It is of interest to note that of the irrigated lands, 550,000 acres are on the high plains of the Texas Panhandle and about 400,000 acres are rice lands in southeast Texas where the average rainfall ranges from 40 to 50 inches. The progressive east Texas farmer who has an average annual rainfall of 40 to 50 inches is beginning to employ irrigation methods to increase other crop yields in the dry summer months.

In 1940, Texas' industry was expanding at a satisfactory rate. The Champion Paper Mill near Houston and the Southland Paper Company at Lufkin, both of which require large quantities of industrial water, had been placed in operation, thus initiating a new industry for the State. The Dow Chemical Company was extracting magnesium, bromine, and other chemicals from sea water at Freeport for the first time. The oil, steel, and chemical industries along the Texas coast from Beaumont to Corpus Christi had reached major operations and their daily water demands, in some areas, were beginning to exceed the unregulated flow of Texas' rivers. Withdrawals of ground water were beginning to lower the water table at an excessive rate in a few areas. Soap, cheese, and other food processing plants, garment factories, and many other smaller new industries were developing in various sections of Texas. This is a brief story of the pre-war conversion of an agriculture and stock-raising State to one that would take its place in the industrial development of the nation.

The Japanese attack on Pearl Harbor changed quickly this peace-time development. Texas' natural resources of oil, gas, sulphur, and fresh water were called upon to supply, at previously unheard of quantities, synthetic rubber, high octane gasoline, ammunition, fuel oil, and other products made from these basic resources. The history of the manner in which these demands were met is well known, but many new war industrial plants, the cost of which exceeds one billion dollars, now dot the State and are being converted to peace-time operation. Water featured prominently in the location and successful operation of these plants. The U. S. Geological Survey and the Texas State Board of Water Engineers received over three thousand requests for factual water resources data in connection with the proper location and successful operation of nearly all of these plants. For example, an ammunition plant in northeast Texas needed 60 million gallons of water daily; a chemical plant in the Texas Panhandle needed 10 million gallons daily; a nylon salt plant in southeast Texas needed 30 million gallons daily; and many other similar requests were received for industrial water. During the same period, urban populations concentrated in previously unpredicted places, such as the communities for the Lone Star Ordnance Plant west of Texarkana. In 1945, the industrial and agricultural activities in the Beaumont-Port Arthur area needed 500 million gallons of water daily during the summer months of that year. Factual data as to the availability of an ample water supply were extensively used, where available, in all sections of the State. These new industrial activities are now being converted to peace-time needs. Texas, and especially the coastal area, is being referred to as the future chemical and plastic production center of the world. The large resources of oil, gas, sulphur, salt, and sea water essential to such an industry are in that area. Fresh water of the proper quality which is necessary for processing purposes is the one limited resource. Ample water of proper quality can be provided for major expansions in that area and in many other sections if storage reservoirs are constructed and the impounded water, as well as the underground water is intelligently used in a systematic manner. Excessive pollution of both surface and ground waters will eventually retard a community growth. Municipalities and industry must more fully realize their responsibility to the public, as well as to themselves, of purifying polluted waters before they are returned to a stream or to an underground aquifer. Industrial waste treatment plants, as often as not, represent assets rather than liabilities because they develop further by-products and salable materials.

Yes, Texas has outgrown its toddling clothes and is entering its adolescent age. Its voice is changing and its mind is becoming more keenly developed. People are beginning to raise their individual horizons. It has been demonstrated that it is profitable to return the salt-water waste to its original reservoir below the big east Texas oil field rather than to pollute the potable waters of the east Texas streams and to pollute potable water in underground formations above the oil deposit. In October 1946, 94.14 percent of the salt water waste, or an average daily of 448,089 barrels of salt water was returned to its original underground reservoir. During the same period, the oil production averaged 428,928 barrels daily. Oil operators, too, have found that under certain conditions and where salt water waste is not a major problem, it is profitable to inject unpolluted surface water into the oil pool to insure a greater recovery of oil. The Texas State Board of Water Engineers has granted water permits for such oil field operations.

Cities like Dallas, Tyler, Amarillo, San Angelo, Corsicana, Waco, Longview, and others have learned that their present limited supply of water will not meet new industrial and municipal demands. Their citizens are beginning to realize that water cannot be considered to be a presumed resource and that it must not be exploited to the detriment of others. They are asking—where can additional water be developed in an economical manner?

If Texas' complete development is to be attained, it is essential that the present program of collecting data revealing the quantity and quality of surface and ground water resources be extended to all sections of the State and the data be made readily available to designing engineers as they are called upon to design water-use and water-control structures.

## A MANUAL OF OYSTER PLANTING

by

J. L. Baughman

### Abstract

In this paper, prepared as a bulletin for the Texas Game, Fish and Oyster Commission, an attempt has been made to cover the available and pertinent information on the Texas oyster industry. A short discussion of the history and over-all economic value of these shellfish throughout the world is given by way of introduction, then the balance of the paper is devoted largely to this state.

The physiography and hydrography of the coasts are extensively discussed, bay by bay, in their relationship to the occurrence of oysters, and available salinity material is given. The history of the industry is given from about 1890 until the present time, with records of the actual production for the last 36 years, which show that the peak year for the business was in 1904, when 199,000 barrels were produced. Since then production has steadily declined, until at present we are only obtaining about 40,000 to 50,000 barrels per year. Reasons for the decline are shown to be both natural and artificial.

The history of oyster planting in Texas is given in some detail, and it was found that from nearly 7,000 acres of oyster bottom under lease in 1904, the area of bottom leased had declined to the low total of 506 acres at the present time. Of this only a small proportion is actually farmed. Results of early surveys of our bays are given along with data on the most recent attempts made by the state to rehabilitate reefs in the Aransas Bay area.

The biology of the oyster is given with data on seasonal variations along the Texas coast, and the average production in gallons per barrel at different times during the year.

The food value is discussed, both in relation to normal usage, and as a food for persons suffering from anemia. It has been found that oysters, due to their high mineral content, are of exceptional benefit when used in the diet of persons afflicted with this disease.

The pests affecting Texas oysters are listed, and an extensive and hitherto unpublished paper by Collier and Federighi is incorporated in this bulletin. These pests are of several kinds. Crabs, drills and other invertebrates are the most harmful among the lower orders of animals. The status of **Nematopsis**, a sporozoan parasite, has not yet been determined on this coast although it is known to cause some damage. One fish, the drum, also causes serious damage to the reefs, and one bird, the oyster catcher, is mentioned, although it causes only a very minor loss.

Pollution problems, both industrial and domestic, are taken up. Extensive material on oil field and pulp mill pollution is given, and an appendix is devoted to the state rules and sanitary regulations applying to the shell fish industry.

A large section is devoted to oyster farming. Choice of bottom is dealt with, and suggestions are given for the improvement of bottoms not otherwise suitable for oyster culture. The procedure necessary to obtain an oyster lease in Texas is given. The obtaining of seed is discussed, along with the proper modes for planting, and the various types of cultch and its use. Data are furnished on the artificial enrichment of the food resources on oyster grounds, with some suggestions on the possible use of fertilizers of various types for this purpose.

Another portion of the paper is devoted to methods of gathering oysters and descriptions of the various types of gear used, such as tongs and dredges. Preparation for market, with comparisons of salt and floated oysters, is included. Locations for shucking houses, plans for the same and processes of opening are detailed for the use of those interested, as well as methods of washing, grading, shipping and disposal of shells.

An extensive question and answer section is devoted to actual questions that have been asked from time to time on the various phases of the oyster industry.

A list is given of the oyster leases now active in Texas, with their acreage, as are the laws governing the farming and taking of oysters in this state.

The history of the Japanese oyster in America is discussed along with its advantages and disadvantages, and the possibility of producing a hybrid form by crossing it with native oysters.

A full resume is given of the use of mudshell in the state, with the production figures over a period of years. Data are given on the industries dependent on this resource, and a section is devoted to the laws governing its use.

The problems of the oyster and mudshell industries are discussed, and recommendations are made for their conservation.

A third appendix is devoted to the most recent development in the various phases of both industries and an extensive bibliography on oysters is incorporated at the end of the book.

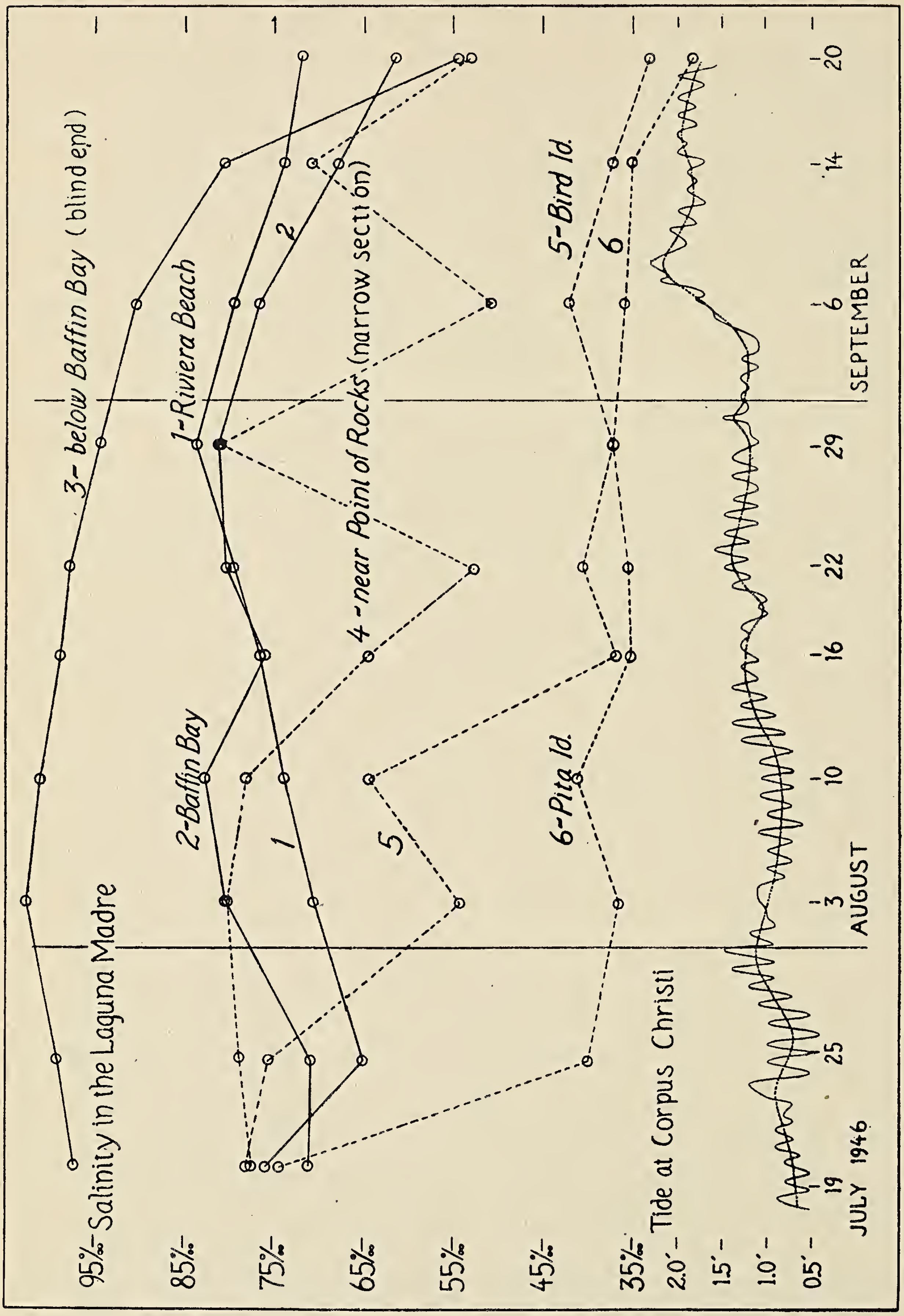
J. L. Baughman—Chief Marine Biologist,
Texas Game, Fish and Oyster Commission,
Rockport, Texas.

## SALINITIES IN THE LAGUNA MADRE

JOEL W. HEDGPETH, Fish, Game and Oyster Commission, Rockport

The Laguna Madre of Texas is about 130 miles long and from three to five miles wide. In depth it ranges from a few inches to five or six feet with occasional deeper holes. In 1919 the Laguna was divided in two by movement of sand below Baffin Bay as a result of a hurricane that year. Because there is no adequate drainage into the Laguna and because it lies in an area where evaporation equals or exceeds rainfall, the Laguna becomes very salty. Salinities are often twice that of normal sea water (35%) and sometimes three times as salty, but in normal years its salinity, while very high does not cause extensive mortality to fish. On the contrary fish seem to thrive in this salty water, to such an extent that it usually produces 50% or better of the entire catch from Texas bays. In 1945-6 the upper Laguna Madre alone produced 1,031,058 pounds, or 31% of the Texas bay fish reported.

Since July 19, 1946 a series of salinity samples has been taken from six stations in the upper Laguna Madre by airplane. These nearly simultaneous samples indicate that the water tends to separate into two parts at a mile wide constriction about 25 miles below the junction with Corpus Christi Bay. It is apparent that salinity exchange in this body of water is primarily a tidal action. When the tide rises, the salinity falls at each station in order, and when it recedes the salinity rises, indicating that mixing with the lower layers of denser, more saline water is incomplete. The break in salinities caused by the constriction of the Laguna to about a mile in width by a sand bar indicates that a channel of this width is inadequate, and that damming the Laguna by dirt filled causeways would so inhibit salinity exchange that the Laguna Madre would become a brine pool, and its value as one of the most important sources of fish on the Texas coast would be destroyed.


95‰- Salinity in the Laguna Madre
85‰
75‰
65‰
55‰
45‰
35‰
Tide at Corpus Christi
2.0'
1.5'
1.0'
0.5'
3- below Baffin Bay (blind end)
1-Riviera Beach
2-Baffin Bay
4-near Point of Rocks (narrow section)
5-Bird Id.
6-Pita Id.
1
2
5
6
JULY 1946
19
25
3
AUGUST
10
16
22
29
6
SEPTEMBER
14
20

# SOILS, FERTILIZERS AND NUTRITION

by Roy L. Donahue

(Paper prepared for presentation before Conservation Section of the Texas Academy of Science in Dallas, December 13 and 14, 1946)

The agronomist is concerned primarily with increasing the yield of crops, whereas the nutrition specialist attempts to find the role of these crops in diets and rations.

Between agronomy and nutrition lies a fascinating field dealing with the influence of soil conditions on plant composition and the resulting effect upon human and animal health and growth.

Are the elements essential for plant growth the same as those for animal and human growth? Is the chemical and nutritional value of any one crop plant a constant, or can it be modified by agronomic practice?

These are some of the vital questions discussed in this paper.

## Essential Elements for Plants and Animals

According to our present knowledge, plants require 14 elements for growth and reproduction. These are carbon, hydrogen and oxygen —which come from air and water. They constitute about 95% of the dry weight of the plant. The other elements needed come from the soil; they are calcium, phosphorus, potassium, sulfur, iron, nitrogen and magnesium. The trace elements from the soil are copper, boron, manganese and zinc.

People and animals require these same 14 elements, and in addition they need common salt (sodium and chlorine), cobalt and iodine. Probably other elements also are essential but they have not yet been demonstrated.

"Of these, (essential elements) only four—calcium, phosphorus, iron and iodine—are likely to be deficient in ordinary diets." * For animals probably copper and cobalt are more frequently limiting than iron.

This paper will therefore be limited to a discussion of deficiencies of calcium, phosphorus, iron and iodine and methods of alleviating these deficiencies through agronomic practice.

The Problem: Mineral Deficiencies (With special reference to Texas) **

"IF THE SOIL DOES NOT HAVE IT IN IT, THE PLANTS THAT GROW THERE DO NOT, OR THE ANIMALS THAT EAT THOSE PLANTS, OR THE PEOPLE WHO EAT THOSE PLANTS AND ANIMALS," so speaks Robert Flaherty in the sound film, "The Land."

Many food and feed crops are frequently found deficient in calcium and phosphorus. The role of iron is somewhat unique. Soils always contain sufficient **total** but oftimes not enough **available** iron for plant growth. Iodine in soils and plants varies widely and is closely tied to definite symptoms of nutritional diseases of animals.

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* Food and Life—Yearbook of Agriculture, 1939. U.S.D.A. p. 9-10.

** It is assumed in this paper that the higher the mineral content of food and feed crops, the more value they have nutritionally. This is not always true. It is recognized that the minerals may not all be available to the animal because they are out of balance or possibly for other reasons.

What are the deficient minerals in Texas? In what areas are they found?

Summarizing data from all over the world, Dr. Kenneth C. Beeson, Chemist for the Bureau of Plant Industry, tabulated results from 607 published works and 23 unpublished materials.[*] The aim was to report the mineral composition of field-grown food and feed crops as influenced by the soils in which they were grown. (Dr. Beeson's data are given in Tables I-IV)

**Calcium**

Even though plants may be growing normally from the animal nutrition standpoint they may be deficient in calcium.[**]

A glance at map 1 reveals that there are 56 East Texas counties needing lime for the best growth of nutritious legumes and pasture grasses.

The variation in calcium content of six food crops and five feed crops, shown in Table I, may be summarized as follows:

1) Turnip greens have the highest average calcium content of any of the crops shown here, while tomatoes have the lowest.

2) Of the feed crops, alfalfa hay averaging 2.01% is the highest in calcium, with corn the lowest.

3) Variation in the calcium percentage is great for both food and feed crops depending on the soil, on the fertilizers used and on the climatic conditions under which the plants were grown.

TABLE I

Variation in the calcium content of selected crops.[1]

| Plant or portion of plant | No. of analyses | Calcium (% Ca) | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| | **FOOD CROPS** | | | |
| Cabbage, edible portion | 89 | 1.78 | 0.41 | 0.73 |
| Carrots | 35 | 0.56 | 0.24 | 0.40 |
| Lettuce | 17 | 1.38 | 0.33 | 0.77 |
| Spinach | 45 | 2.78 | 0.51 | 0.21 |
| Tomato, fruit | 58 | 0.48 | 0.08 | 0.24 |
| Turnip, top | 14 | 4.755 | 1.49 | 3.28 |
| | **FEED CROPS** | | | |
| Alfalfa, hay, half bloom, all cuttings | 130 | 4.15 | 0.59 | 2.01 |
| Barley, grain | 252 | 0.150 | 0.015 | 0.064 |
| Corn, grain | 127 | 0.045 | 0.006 | 0.015 |
| Oats, grain | 170 | 0.19 | 0.05 | 0.10 |
| Wheat, grain | 290 | 0.122 | 0.005 | 0.050 |

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[*] Beeson, Kenneth C. The mineral composition of crops with particular reference to the soils in which they were grown. U.S.D.A. Misc. Pub. 369, 1941.

[**] Forage below 0.32% lime (Ca 0) is usually considered deficient.

[1] From U.S.D.A. Misc. Pub. 369, 1941.

**Phosphorus**

Phosphorus deficiency in Texas is the most widespread of any essential mineral.* The soils are low in both total and active (available) phosphorus.

Map 2 shows that the East Texas Timber Region, the Gulf Coast Prairie, and the West Cross Timbers as well as other smaller areas are all very low in active phosphorus.

Not only are the soils low in phosphorus but the plants growing thereon are also so low that livestock deficiency symptoms have been reported in the eastern half of Texas (map 3).

The variation in the phosphrous content of food and feed crops is seen in Table II. At a glance one can see that:

1) The phosphorus content of all crops shown fluctuates widely.

2) The amount in all crops is low.

3) Spinach is the most phosphorus-rich food while corn contains the most of any feed shown.

TABLE II

Variation in phosphorus content of selected crops. **

| Plant or portion of plant | No. of analyses | Phosphorus (% P.) | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| | **FOOD CROPS** | | | |
| Cabbage, edible portion | 113 | 0.77 | 0.13 | 0.38 |
| Carrots | 53 | 0.65 | 0.14 | 0.33 |
| Lettuce | 30 | 1.05 | 0.19 | 0.56 |
| Spinach | 62 | 1.17 | 0.27 | 0.72 |
| Tomato, fruit | 62 | 0.84 | 0.29 | 0.55 |
| Turnip, top | 22 | 0.82 | 0.14 | 0.39 |
| | **FEED CROPS** | | | |
| Alfalfa, hay, half bloom, all cuttings | 288 | 0.51 | 0.14 | 0.27 |
| Barley, grain | 316 | 0.62 | 0.15 | 0.41 |
| Corn, grain | 197 | 0.80 | 0.23 | 0.43 |
| Oats, grain | 233 | 0.53 | 0.15 | 0.34 |
| Wheat, grain | 310 | 0.54 | 0.15 | 0.40 |

**Iron**

The amount of iron variation in a food crop is best summarized by a certain cooperative research project carried on by six southern states, namely, Georgia, Mississippi, Oklahoma, South Carolina, Virginia and

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* Forage below 0.33% P205 is usually considered deficient.

** From U.S.D.A. Misc. Pub. 369, 1941.

Texas. These worked jointly on studying the effect of fertilizer and environment on the iron content of turnip greens. *

Briefly, the results of this work showed:

1) Turnip greens varied 400-500% in iron content.

2) The higher the organic matter in the soil, the higher the iron content in the turnip greens.

3) Nitrogen fertilizers increased yields but decreased the iron content of turnip greens by 20%.

The iron content of selected food and feed crops is seen in Table III. Of the food crops, lettuce averages the highest, whereas alfalfa hay is the most iron-rich feed crop shown here.

TABLE III

Variation in iron content of selected crops. **

| Plant or portion of plant | No. of analyses | Iron (Milligrams per kilogram) | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| | **FOOD CROPS** | | | |
| Cabbage, edible portion | 67 | 305 | 11 | 95 |
| Carrots, roots | 27 | 490 | 49 | 179 |
| Lettuce, edible portion | 27 | 4,830 | 65 | 1,034 |
| Spinach, edible portion | 54 | 1,750 | 54 | 683 |
| Tomato, fruit | 56 | 800 | 48 | 202 |
| Turnip, top | 7 | 2,483 | 140 | 618 |
| | **FEED CROPS** | | | |
| Alfalfa, hay | 19 | 629 | 132 | 275 |
| Barley, grain | 23 | 350 | 14 | 99 |
| Corn, grain | 4 | 50 | 25 | 37 |
| Oats, grain | 34 | 350 | 7 | 79 |
| Wheat, grain | 131 | 420 | 28 | 68 |

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* Effect of fertilizer and environment on the iron content of turnip greens.
Southern Cooperative Series Bul. 2, 1944.

** From U.S.D.A. Misc. Pub. 369, 1941.

**Iodine**

A comprehensive report was published in 1940 which brought the iodine problem up to date in Texas. *

A few quotations from this bulletin will best summarize the information: "Iodine in 37 samples of vegetables ranged from 62 to 3,502 parts per billion . . . Iodine in Texas vegetables was much higher than in corresponding vegetables from goitrous areas. Iodine in 103 samples of city water ranged from 4 to 312 parts per billion . . . Only 3 samples of city water contained less than 10 parts per billion, the quantity thought by some investigators to be sufficient. Iodine in 56 samples of roughages and grasses ranged from 17 to 1,125 parts per billion."

While iodine does not often appear to be deficient in diets and rations in Texas, throughout most of the humid regions of the United States (in other than coastal plains soils) iodine is added to table and stock salt to prevent goiter.

Table IV shows variations and averages of iodine content in selected food and feed crops. Of the crops shown in this table spinach and corn are the most iodine-rich food and feed crops, respectively.

TABLE IV

Variation in iodine content of selected crops. **

| Plant or portion of plant | No. of analyses | Iodine (parts per billion) | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| | FOOD CROPS | | | |
| Cabbage, edible portion | 85 | 791 | 16 | 218 |
| Carrots, roots | 35 | 2,400 | 2 | 309 |
| Lettuce, edible portion | 41 | 6,740 | 71 | 1,137 |
| Spinach | 91 | 48,650 | 19 | 9,382 |
| Tomato, fruit | 22 | 660 | 20 | 233 |
| Turnip, top | 22 | 676 | 111 | 255 |
| | FEED CROPS | | | |
| Alfalfa, hay | 4 | 385 | 69 | 157 |
| Barley, grain | 5 | 124 | 73 | 102 |
| Corn, grain | 21 | 650 | 63 | 177 |
| Oats, grain | 13 | 175 | 10 | 57 |
| Wheat, grain | 26 | 168 | 0 | 67 |

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* Fraps, G. S. and Fudge, J. F., Iodine in drinking waters, vegetables, cottonseed meal and roughages. Texas Agricultural Experiment Station Bul. 595, 1940.

** From U.S.D.A. Misc. Pub. 369, 1941.

## Agronomic Solution to Mineral Deficiencies

Many agronomists claim that they can cure most nutritional ills by:

1) Proper selection of crops.

2) Suitable sequence of crops in a rotation.

3) Adequate liming, fertilization and manuring of these crops.

4) Modification of soil conditions to facilitate uptake of nutrients by plants.

The accomplishments of the agronomist in the solution of the problems arising from deficiencies of calcium, phosphorus, iron and iodine (the four essential elements most frequently deficient) in plant, animal, and human nutrition are as follows:

### Calicum

Calcium is applied to field and truck crops mainly in the form of ground limestone. The lime requirement is determined by testing the acidity of pH of the soil. And in general, most food and forage crops will have adequate calcium when growing in a soil with a pH above 6.0. The optimum pH for most crops is between 6.0 and 7.0. If the pH is too high, the uptake of these nutrients may be depressed.

So under practical field conditions, applications of limestone of about one to two tons per acre are made when the pH of the soil is below 6.0.

What happens to the chemical and nutritional value of plants when limestone is applied? In a six-state cooperative project * the calcium content of turnip greens increased as the exchangeable calcium and pH increased. There was also a positive correlation between the level of soil organic matter and the calcium—the higher the organic matter the more the calcium in the turnip greens. An interesting fact was also found regarding the use of nitrogen fertilizers. Whereas the applied nitrogen increased turnip top yields by over 30% it decreased the percentage of calcium in 24 out of 30 experiments. Let's look at a report from the Texas Agricultural Experiment Station. **

Limestone applied on a Gulf Coast Prairie soil resulted in:

1) A 45% increase in forage yield.

2) An 18% increase in calcium content of the forage.

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* Sheets, O. A. et. al, Effect of fertilizer, soil composition, and certain climatological conditions on the calcium and phosphorus content of turnip greens. Jour. Agr. Res. V. 68, 145-190, 1944.

** Fudge, J. F. and Fraps, G. S., The chemical composition of forage grasses from the Gulf Coast Prairie as related to soils and to requirements for cattle. Texas Agri. Exp. Sta. Bul. 644, 1944.

**Phosphorus**

In the same experiment on the Gulf Coast Prairie, the application of a phosphorus fertilizer gave the following responses:

1) A 107% increase in yield of forage.
2) A 52% increase in phosphorus content in forage.
3) A 30% increase in protein content in forage.
4) A 35% increase in calcium content in forage.

When **lime** and **phosphorus** were both applied, an **additional increase** was reported, consisting of 46% more forage yield, 7% more phosphorus, 5% more protein, and a percentage composition of 32% more lime (calcium) as compared to an application of lime alone.

In summarizing the results of 12,000 forage analyses during the past 10 years, Dr. J. F. Fudge, of Texas Agricultural Experiment Station, presented the data from which Table V was calculated. *

TABLE V

| Region | Forage samples deficient in protein (below 12% protein) | Forage samples deficient in phosphorus (below 0.33% P205) |
|---|---|---|
| | % | % |
| East Texas Timber | 41 | 63 |
| Gulf Coast Prairie | 45 | 74 |
| Northwest Texas | 37 | 65 |

In the same paper Fudge cited the results of an experiment at the King Ranch (Encino) as follows:

TABLE VI

| Treatment | Live weight of beef calves produced per acre per year. (pounds) |
|---|---|
| No phosphate on pasture | 26 |
| Phosphate on pasture ** | 47 |
| No Phosphate on pasture but cattle had free access to bone meal | 30 |

In the above table it is obvious that phosphate fertilizer when applied to the pasture was responsible for an increase of 21 pounds of beef produced per acre per year—an 81% increase due to the phosphate fertilizer. It is very interesting to compare this increase with the gain when bone meal was used as a feed supplement—an 81% increase over the check when phosphate was applied on the pasture as against a 15% increase over the check when bone meal was fed to the beef animals and no phosphate was applied on the pasture.

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* Fudge, J. F., The relation between the chemical composition of soils and the feeding quality of forage. Paper presented at the Texas Nutrition Conference, April 8 and 9, 1946. A & M College of Texas, College Station, Texas.

** Phosphate was applied at the rate of 200 pounds of TVA 48% phosphate per acre.

On food crops the phosphorus can also be increased by good agronomic practice. For example, Dr. O. A. Sheets, et al, on a cooperative project involving Virginia, Georgia, Oklahoma, South Carolina, Mississippi and Texas * found that:

1) The higher the phosphorus content of the soil the higher the phosphorus content of turnip greens.

2) As the soil organic matter increased the phosphorus content of turnip greens also increased.

And phosphorus does more than just make pasture grasses stronger, cattle gain more weight and turnip greens higher in phosphorus—it helps people too.

After 5 years of using a high analysis TVA phosphate, one of our Extension Service Farm Unit Demonstrators says: "Everyone's stock that use fertilizer, look better and even the people themselves look better and I think the Farm Unit Demonstrations are grand and if kept up will finally have improved conditions in all this poor sandy land country, where ten years ago it looked very much like we were going to have to move out of this country or quit farming it."

## Iron

The six-state cooperative study of iron in turnip greens ** mentioned previously, shows clearly that high soil organic matter means high iron content.

It is logical to assume, therefore, that if we build up the soil organic matter we can expect an increase in percentage composition of iron in plants, more specifically, in turnip greens.

To build up the soil organic matter under field conditions is a job for the agronomists. Practically, it involves the use of:

1) More winter and summer legumes plowed under.
2) More grass crops in rotation with cultivated crops.
3) Liberal use of lime, commercial fertilizers and farm manures.

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* Sheets, O. A. et al, Effect of fertilizer, soil composition and certain climatological conditions on the calcium and phosphorus content of turnip greens. Jour. Agri. Res. V. 68, 145-190, 1944.

** Effect of fertilizer and environment on the iron content of turnip greens. Southern Cooperative Series Bul. 2, 1944.

[1] Fraps, G. S. and Fudge, J. F., Iodine in drinking waters, vegetables, cottonseed meal and roughages. Texas Agri. Exp. Sta. Bul. 595, 1940.

### Iodine

Whereas Drs. Fraps and Fudge[1] conclude that drinking water, food and feed crops are so high in iodine that, "The use of iodized table salt for human consumption in Texas is not advisable, except under the supervision of a competent physician. The use of iodized mineral mixtures for livestock in Texas is not recommended."

However, with 3 samples of city water deficient in iodine of a total of 103 analyzed, more data needs to be collected before the final answer is obtained.

## Summary and Conclusions

The agronomist has a definite privilege and responsibility in helping to solve nutritional deficiencies of both people and animals.

Of the 18 elements essential for animal nutrition, only four are found frequently deficient, namely, calcium, phosphorus, iron, and iodine.

Calcium is frequently a limiting factor in plant and animal growth in 56 East Texas counties. The practical agronomic cure is between one and two tons of limestone per acre if the soil has a pH below 6.0.

Phosphorus is the most frequently limiting factor in plant and animal nutrition in Texas. Livestock deficiency symptoms have been reported for the eastern half of the state. The agronomic treatment is the application of a minimum of 20 pounds of P205 per acre per year.

The iron content of turnip greens is higher when grown in soils high in organic matter. It is therefore postulated that if we build up the organic content of a soil by good farming practices, we will then produce food and feed crops higher in iron.

Iodine in Texas waters, vegetables and forage crops is reported as adequate, but may require further study.

If the agronomist and the nutritionist would join forces more often, studying each other's problems, we could then have more facts on these vital issues that bring about greater health and happiness:

1) What specific influence does fertilizer, farm manure, lime and green manuring practices have on the quality of food and feed crops?

2) What relationships exist between plant and animal vitamins when animals graze on fertilized pastures? Is the meat then worth more as human food?

3) Can we build up a quality-conscious consumer who will pay more for alfalfa hay higher in calcium, or turnip greens richer in iron?

These questions and many others can be solved by a scientific approach and a more cooperative spirit.

## Acknowledgment

The writer wishes to express his sincere appreciation to these men and women from the A & M College of Texas who, even though they are very busy, took time out to read this paper and to offer their helpful criticisms.

Dr. Paul B. Pearson, Professor of Animal Husbandry

Dr. J. E. Adams, Head, Department of Agronomy

J. C. Smith, Agronomist for the Experiment Station

M. K. Thornton, Agricultural Chemist, Extension Service

Edith Lawrence, Food Preservation Specialist, Extension Service

Florence Low, Associate Specialist in Home Management, Extension Service.

Dr. L. G. Jones, Professor of Agronomy

Dr. E. A. Grist, Poultry Veterinarian, Extension Service

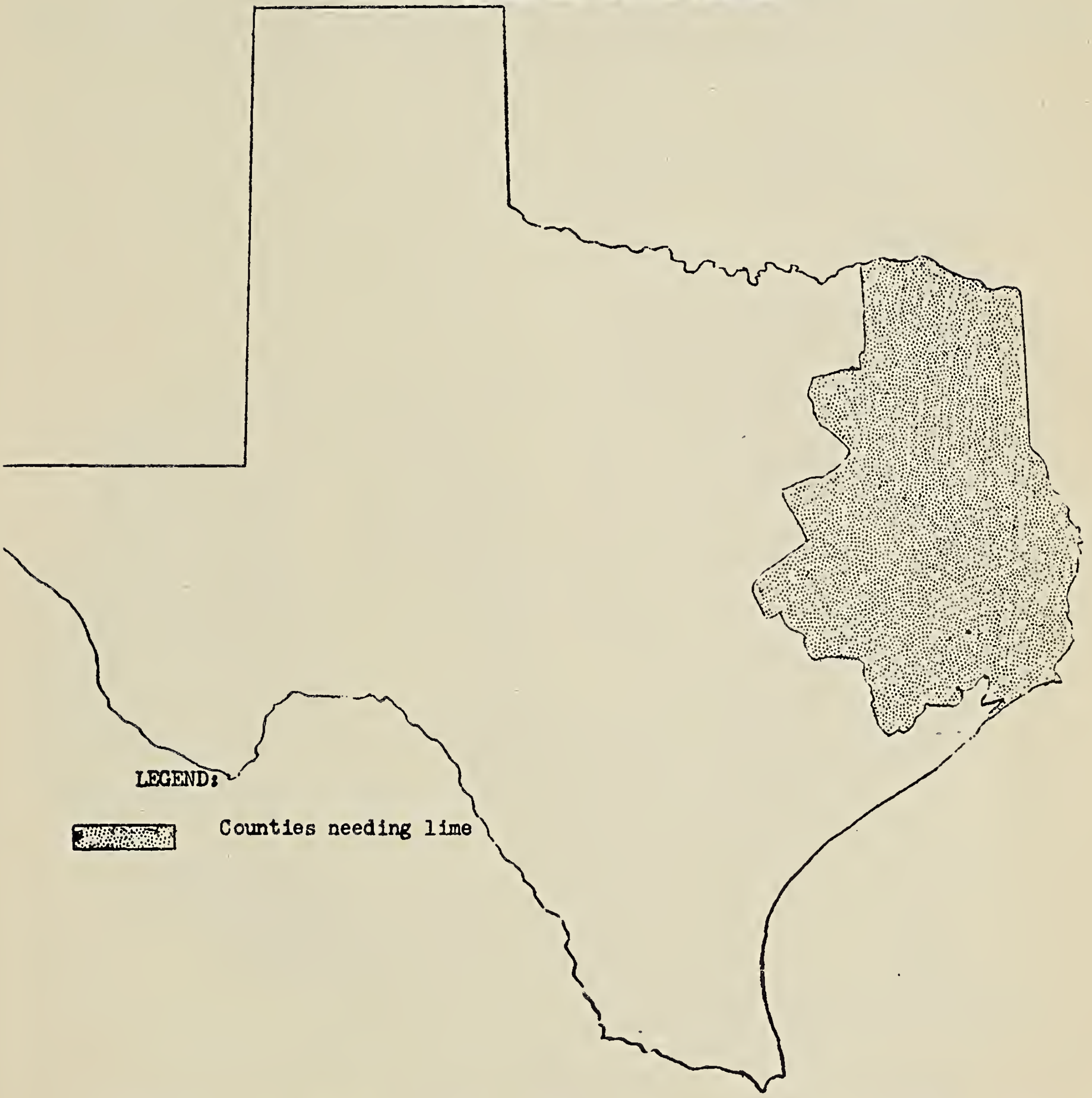
Dr. H. E. Hampton, Associate Professor of Agronomy

Dr. J. F. Fudge, Chief, Division of Chemistry and State Chemist.

Special appreciation for criticizing this paper is due Dr. Robert F. Chandler, Jr., Charles Lathrop Pack, Professor of Forest Soils at Cornell University, Ithaca, New York.

MAP 1

TEXAS SOILS IN NEED OF LIME FOR THE BEST GROWTH OF NUTRITIOUS LEGUMES AND PASTURE GRASSES.*



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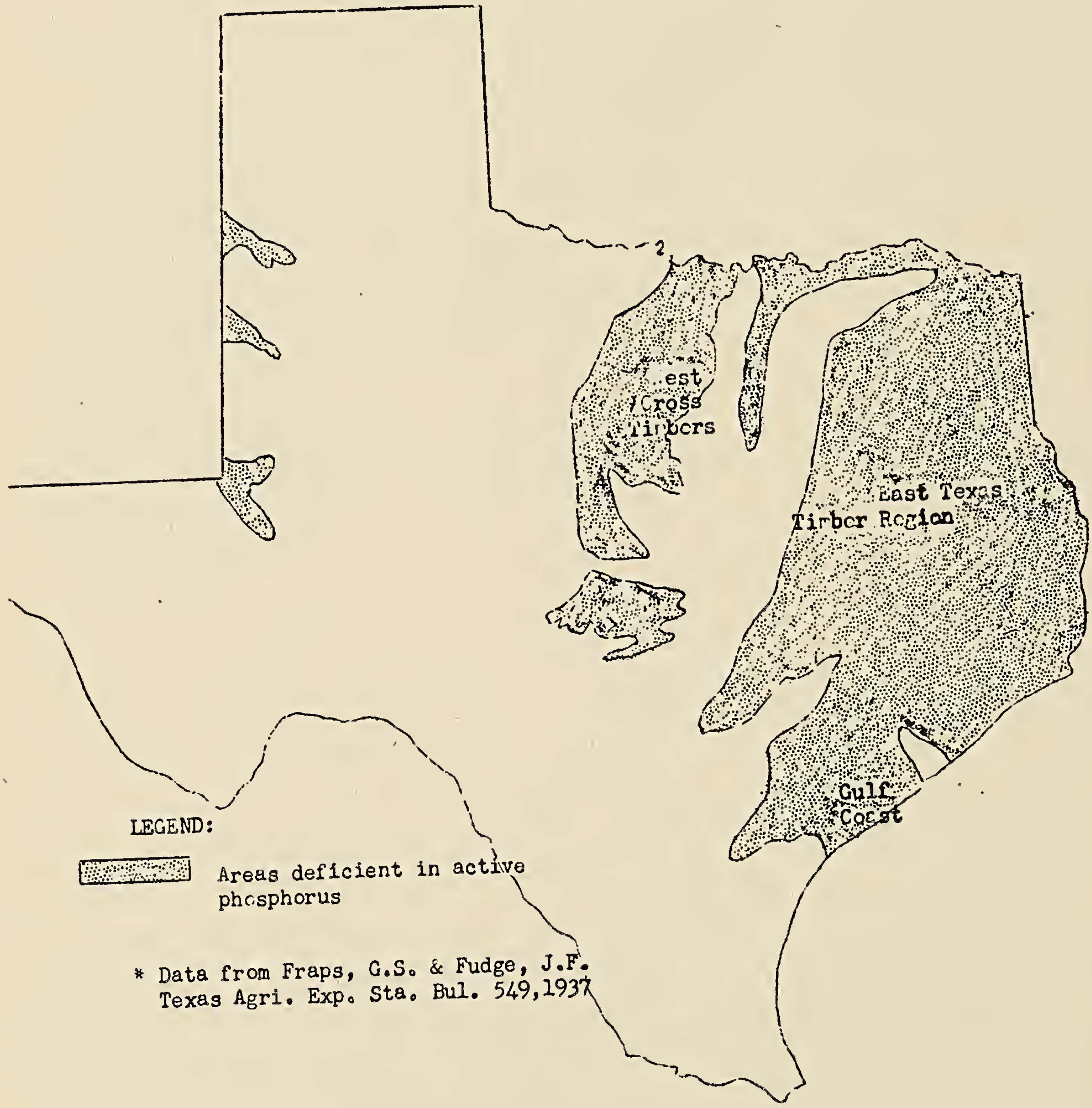
* Data from Dr. Luther G. Jones, Prefessor of Agronomy, A. & M. College of Texas, 1945

## MAP 2

## PHOSPHORUS DEFICIENCY IN TEXAS SOILS *

(The East Texas Timber Region, the Gulf Coast Prairie and the West Cross Timbers are deficient in active phosphorus)



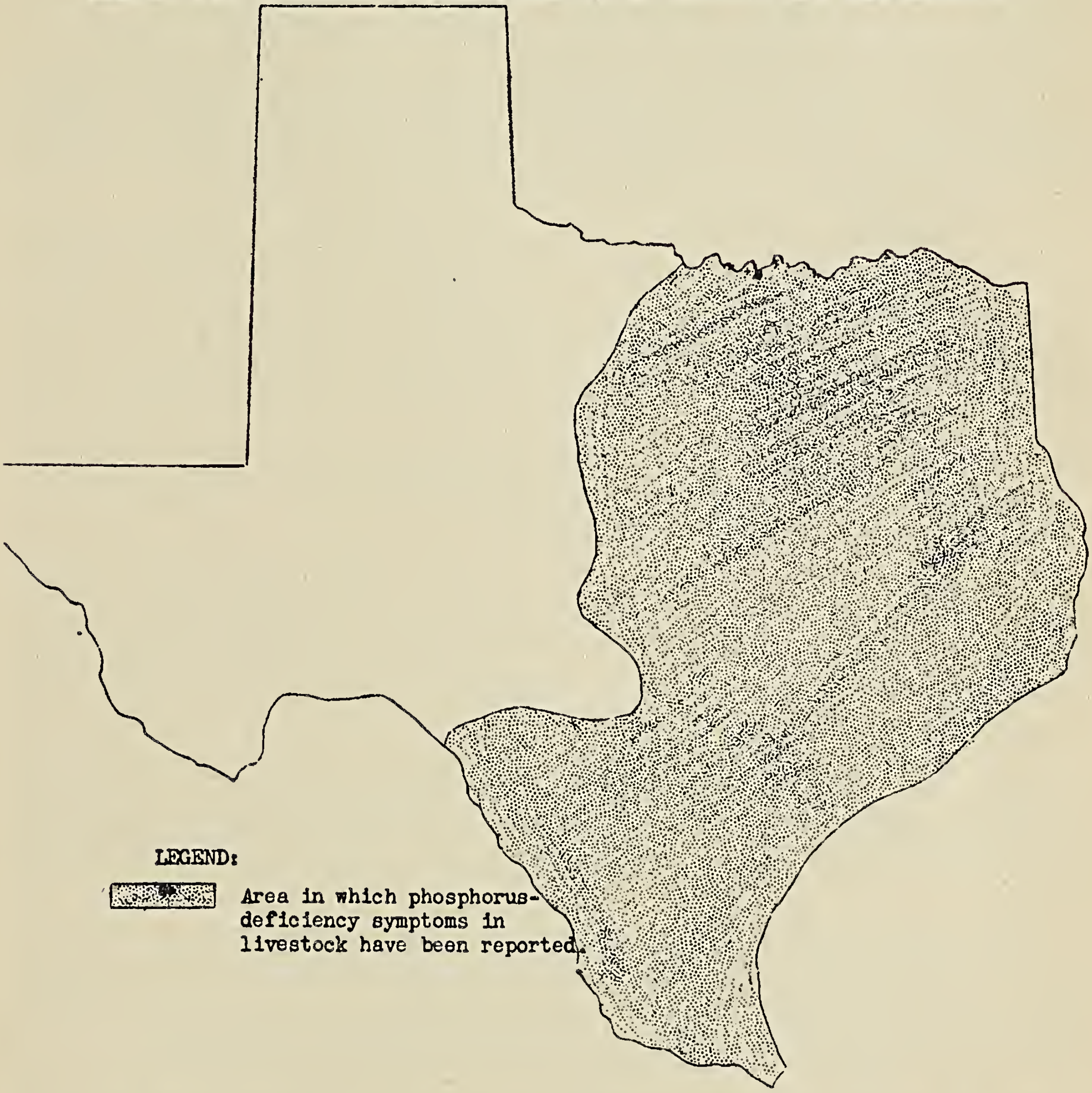
LEGEND:

▨ Areas deficient in active phosphorus

* Data from Fraps, G.S. & Fudge, J.F. Texas Agri. Exp. Sta. Bul. 549,1937

MAP 3

AREA IN WHICH PHOSPHORUS-DEFICIENCY SYMPTOMS IN LIVESTOCK HAVE BEEN REPORTED.*


LEGEND:
▨ Area in which phosphorus-deficiency symptoms in livestock have been reported.

* Data from Food and Life, Yearbook of Agriculture, 1939, p. 1029

## FOREST CONSERVATION AND REFORESTATION

by

W. E. White, Director
Texas Forest Service, A & M College

Texas was once richly endowed with forests as well as with other natural resources. Twenty years ago the need for conservation was not apparent to the public because there still remained a considerable amount of virgin timber and young timber.

Today conservation is a subject of great importance, especially in the commercial pine and hardwood belt of East Texas. Of the original eighteen million acres of forest land in thirty-six East Texas counties there are now 10½ million acres of potential forest land.

Ten years ago East Texas had nearly 1½ million acres of virgin timber as compared with approximately 150,000 acres at the present time. A decade ago there were only 220,000 acres of poorly stocked forest land in East Texas. Now more than 1½ million acres are poorly stocked. This means that more than 85 percent of the poorly stocked and denuded forest land has occurred in the last ten years. The devastated forest land which is not suitable for agricultural crops calls for reforestation and conserving the present merchantable trees and young timber until they are ready to harvest.

Our present commercial forest resources also include about seven million acres of merchantable young growth saw timber, one million acres of pole timber, and 900,000 acres of saplings and seedlings. Thus, we see that East Texas has a great timber potential which needs adequate management and protection.

Now let us consider the forest conditions existing in the East Texas commercial pine and hardwood timberbelt as indicated by the U. S. Forest Service and American Forestry Association reappraisals for 1945.

These appraisals show the following results for the nineteen northeast counties composed of Anderson, Cherokee, Nacogdoches, Shelby, Panola, Rusk, Smith, Gregg, Harrison, Marion, Upshur, Wood, Cass, Morris, Titus, Camp, Franklin, Red River and Bowie counties.

1. The pine sawtimber volume has been decreased by 50 percent. The hardwood sawtimber decreased by 19 percent. This is an average decrease of 39 percent in the pine and hardwood sawtimber during the ten years through 1945.

2. For the seventeen southeast Texas counties of Sabine, San Augustine, Angelina, Houston, Trinity, Walker, San Jacinto, Polk, Tyler, Jasper, Newton, Orange, Jefferson, Hardin, Liberty, Harris and Montgomery counties, the survey showed that the pine sawlog growing stock increased 31 percent, while the hardwoods decreased 17 per-

cent. For the entire timbered area in these seventeen counties the pine and hardwood sawtimber increased 14 percent.

3. For the thirty-six East Texas counties as a whole, the pine and hardwood sawlog timber has decreased three percent in the last ten years. For all of the southern states as a group the decrease has been 14 percent.

From these figures you will note that the timber conditions in the nineteen northeast counties of East Texas have reached a point where it is absolutely necessary that practical forestry conservation methods be applied in order to conserve and build up the growing stock of timber for this area so that it may regain its former place in timber production. In the seventeen southeast counties where a considerable amount of the timberland belongs to large owners who are practicing forestry on their holdings the beneficial results are apparent as is indicated in the survey which shows a 14 percent increase in the pine and hardwood sawtimber classes.

At the end of 1945 the volume of pine and hardwood sawtimber in East Texas was nearly 27½ billion board feet. About 70 percent of this volume is pine and cypress, with the remaining 30 percent being hardwood.

The average stand of pine and hardwood sawtimber in East Texas amounts to 2,600 board feet. Most of these timberlands are capable of growing from five to ten thousand board feet of timber per acre when brought to full production.

The annual growth per acre per year averages fifty-three cubic feet. This is approximately two-thirds of a cord of solid wood, or 156 board feet per acre per year. The timberlands of East Texas will easily grow three to four hundred board feet of timber per acre per year when the timber stands are built up by conservation and proper forestry practices. This fact has been proved since it is now being accomplished on some of the state forests, National forests and private holdings in Texas where sound conservation and forestry management are being practiced.

I believe these facts and figures indicate that it is now time to educate and give field service to the small timberland owners in this area who are mainly responsible for the run-down condition of the forests. This means that the people who own timberland should be shown how to cut less than the annual growth of timber until such time as their lands are carrying a full crop of timber. When this is accomplished the cutting of the annual growth of timber each year, or in five year periods, will maintain the growing stock, or principal, and give excellent returns on the investment continuously.

To obtain this goal, conservation will have to be practiced and much reforestation accomplished. The timberlands of East Texas which are 93 percent in private ownership have been producing timber and contributing to the welfare of the people and state for the past one hundred years without much forestry being applied. However, the forest conditions in the East Texas commercial timberbelt will not stand up under continued poor cutting practices and heavy demand for forest products which have been accelerated by a 25 percent increase in sawmills in the past two years.

The Texas Forest Service has a practical forestry plan for the state that will conserve, reforest and increase the timber production so that the forests will supply all present and future demands on them by the forest products industries.

In order to practice forestry conservation and increase timber production on privately owned timberlands, when sufficient funds become available the Texas Forest Service of the A & M College of Texas will be responsible for the following:

1. Reduce fires on fourteen million acres of timberlands in the East Texas commercial timberbelt and the East Texas post oak area, much of which is not now being protected from forest fires due to lack of funds. Approximately 6,600 forest fires cause an estimated damage of more than two million dollars yearly. The percentage of the unprotected area which is burned annually is four times as great as on the land given protection.

2. Provide technical assistance to 60,000 small woodland owners in these areas. This will require the employment of more technical foresters to do on-the-ground service forestry work with the small timberland owners. At our present rate of performing this service it will take over a hundred years to complete the project.

3. Develop new uses for Texas timber through research. Research is needed in timber growing techniques and utilization of timber wasted by logging and milling. Expansion of present Texas Forest products laboratory facilities at Lufkin, Texas plus more technical personnel will be essential in solving these problems.

4. Develop and demonstrate the best methods of growing timber by silvicultural research. More small state forests in the different timber type areas and more technical forestry personnel will be required to speed up this phase of forestry.

5. Grow more seedling commercial trees to reforest idle acres and supply windbreak and shelterbelt needs. This requires expansion of the present nursery at Alto, Texas plus one nursery in west Texas and one more in East Texas. The interest in tree planting in Texas is increasing. This year the demand for seedlings far exceeds the available supply. It is contemplated that production of seedlings will be increased to 15 million by the 1947-48 season.

6. Impart the know-how through education by use of the press, magazines, pamphlets, visual education and radio. It requires this type of educational work plus actual on-the-ground service to the small timberland owners to create their interest in practicing good timber growing methods and forest management work with the owners.

7. Benefits derived from a good state forest conservation program for the East Texas commercial timberbelt, post oak, cedar brakes, mes-

quite and west cross timber areas will aid financially some 140,000 farmers, ranchers and other small woodland owners—almost 1,000 forest products industries and allied wood using industries and their 50,000 employees plus forest industries that will come into the state. This will make for prosperous local communities in the timbered areas, pay taxes, rejuvenate the renewable forest resources and increase the receipts of the forest products industries which now amount to over 100 million dollars annually. Many Texas merchants, doctors, bankers, communities, schools and counties where timber is of major importance derive indirect benefits. The Texas public derives benefit from this home grown and home manufactured supply of wood products as forest products brought into the state from outside sources naturally cost more than those manufactured in the state. Forest products research work on finding new uses for present unmerchantable hardwoods and utilization of wood waste will be of great benefit to ranchers who will then be able to obtain compensation from timber eradication projects on their grazing lands as it will help to defray the costs of the eradication work.

East Texas is a region where a major portion of the population talk timber and depend on it. Whole communities are built up around forest industries and productive timberlands. Their future and ours depends on keeping those timberlands productive. Conservation is a necessary and important function if the forests are to continue to yield their benefits. This does not mean that our forest resources are important only to the people of East Texas. The management and restoration of our forests are of vital concern to all the people of our state. Sixty-eight percent of the annual timber harvest is used within our state. This amounts to 220 board feet per year for every person in Texas.

Forests contribute much to the welfare of mankind in addition to supplying hundreds of commercial products. Trees are leading characters in the great drama of man's battle against floods, drought and erosion. Most of the virgin forests which once stood as majestic sentinels guarding our heritage of scenic streams and fertile lands are gone. We are now writing a new story of man's effort to become an ally instead of an enemy of nature. In this plot we find the forester and the engineer, the soils specialist and the geologist combining their knowledge and experience to make our soil, forest and water resources contribute more to human welfare.

Forests contribute much to flood and erosion control by regulating the amount and rate of runoff. Although forests can never completely prevent floods, the maintenance of good forest cover at the headwaters of streams is recognized as fundamental in flood control. It will not be possible to reforest all steep land which needs protection. However, much can be accomplished by proper management of forests on steep land which is better adapted to tree production than to any other land use.

Forests are as closely related to wildlife as to water and soil. Reforestation, erosion control, stream improvement and game restoration should be carried on simultaneously. The real problem in the management of all resources is to work with nature in such a way as to maintain a satisfactory relation between all plant and animal life. Forests are a major factor in maintaining the "balance of nature."

The forest is the natural habitat of many species of game animals and birds. Excessive clearing of wooded land has caused a reduction of the amount of suitable forest range. Deterioration of the quality of forest range results from fire, erosion, overgrazing and overcutting of timber.

To understand the relation of forests to soil, water and wildlife, one must consider several values. All are essential features of the basic principal of multiple land use.

Science is changing the pattern of forestry just as it is changing all other industries. New wood products appear in stores, homes and offices almost every day; so varied are the uses of wood that most of us do not recognize all the items that come from the forest. Some people believe that science will develop new products to take the place of wood and that we shall need fewer trees. It is more probable that science will increase our need for trees by creating new things made from wood.

## FOREST CONSERVATION AND REFORESTATION

EVERETT F. EVANS
Texas Forest Service, College Station

Texas is richly endowed with forests as well as with other natural resources. Almost half of the state is covered with some kind of forest growth, which amounts to an area of approximately 73 million acres. No other state has such a large area in trees. Our state has the unique distinction of containing portions of each of the four major forest regions of America: the Northern Forest, Southern Forest, Central Hardwood Forest and Western Forest.

Texas has approximately eleven million acres of commercial timber. Practically all the forests of commercial importance are located in thirty-six East Texas counties. This does not mean that our forest resources are important only to the people of East Texas. The management and restoration of our forests are of vital concern to all the people in our state. Much of the lumber and other timber products used in the non-forested counties of Texas comes from the piney woods. If the people of West Texas had to depend on timber from other states or foreign countries the cost of homes and all the other necessities made from trees would be much higher.

Sixty-eight percent of the annual timber harvest is used within our state. This amounts to 220 board feet per year for every person in Texas.

Pines constitute the major timber resource of the state. Seven tenths of the commercial forest area of East Texas is pine, and about 85 percent of all lumber produced in Texas is pine. The three native species are longleaf, shortleaf and loblolly. Slash pine, a native of the Gulf Coast east of the Mississippi River, has been introduced into Texas. The adaptability of this species indicates that it will play an increasingly important role in reforestation.

The remaining three tenths of the East Texas commercial timber area is hardwood. Most of the East Texas forests are covered with second growth timber.

Outside the commercial timber region much of the forests are of low economic value. However, these are important as protection forests in the control of runoff, the regulation of stream flow and the checking of soil erosion. The total area of the protection forests is approximately 62 million acres. This region contains a vast amount of wood fiber which may have future commercial value. The post oak area covers more than four million acres and the east-west cross timbers account for another five million acres. West Texas contains several small regions of mountain pine. Mesquite covers above fifty million acres. Through research we are seeking new uses for this species. Besides the well defined forest regions there are scattred stands of live oak.

Texas has 654,000 acres of national forest land administered by the U. S. Forest Service. There are five state forests with a total area of 6,410 acres administered by the Texas Forest Service. The state forests are used mainly for research, demonstration and recreation.

Before leaving the subject of forest resources, it is well to consider briefly the ownership of these resources. One third of the commercial forest land of East Texas is in large holdings of 3,000 acres or more. Two thirds of the state's commercial timberland is in holdings of less than 3,000 acres each. Fifty thousand farmers in East Texas own an average of less than fifty acres each. The difficulty of providing technical assistance, marketing advice and fire protection to that many owners can be readily understood.

A forest is primarily the source of the timber "crop." It should be emphasized that this crop is renewable. Trees are removed by harvesting, but more trees can be grown on the same land. Our forests are our greatest renewable natural resource.

The total yearly value of manufactured products in East Texas is about 100 million dollars. Approximately forty thousand people are employed in forest industries. These employees earn more than forty million dollars. This is a region where a major portion of the population talk timber and depend on it. Whole communities are built up around forest industries and productive timberlands. Their future and ours depends on keeping those timberlands productive. Conservation is a necessary and important function if the forests are to continue to yield their benefits.

During the recent World War II the timber harvest of East Texas reached two billion board feet annually. If half of this timber were used for lumber it would be sufficient to build 60,000 new homes, allowing 15,000 board feet for each home.

Lumber is only one of the products of our forests. From the woods we also get pulpwood for our newspapers, books and magazines. The paper on which the nationally famous Life Magazine is printed is a product of Texas trees. Ties for our railroads, baskets for Texas fruit and vegetables, poles for electric lines and construction, fuel for homes and industry, posts for farm fences and toys for our children all have their origin in the forests.

Science is changing the pattern of forestry just as it is changing all other industries. New wood products appear in stores, homes and offices almost every day. So varied are the uses of wood that most of us do not recognize all the items that come from the forest. Some people believe that science will develop new products to take the place of wood and that we shall need fewer trees. It is more probable that science will increase our need for trees by creating new things made from wood. We cannot predict the future, but we do know that science has made possible the constructive use of some kinds of wood which were formerly destroyed for lack of a market.

Forests contribute much to the welfare of mankind in addition to supplying hundreds of commercial products. Trees are leading characters in the great drama of man's battle against floods, drought and erosion. Most of the virgin forests which once stood as majestic sentinels guarding our heritage of scenic streams and fertile lands are gone. We are now writing a new story of man's effort to become an ally instead of an enemy of nature. In this plot we find the forester and the engineer, the soils specialist and the geologist combine their knowledge and experience to make our soil, forest and water resources contribute more to human welfare.

Forests contribute much to flood and erosion control by regulating the amount and rate of runoff. Although forests can never completely prevent floods, the maintenance of good forest cover at the headwaters of streams is recognized as fundamental in flood control. It will not be possible to reforest all steep land which needs protection. However, much can be accomplished by proper management of forests on steep land which is better adapted to tree production than to any other land use.

Forests are as closely related to wildlife as to water and soil. Reforestation, erosion control, stream improvement and game restoration should be carried on simultaneously. The real problem in the management of all resources is to work with nature in such a way as to maintain a satisfactory relation between all plant and animal life. Forests are a major factor in maintaining the "balance of nature."

The forest is the natural habitat of many species of game animals and birds. Excessive clearing of wooded land has caused a reduction of the amount of suitable forest range. Deterioration of the quality of forest range results from fire, erosion, overgrazing and overcutting of timber.

To understand the relation of forests to soil, water and wildlife, one must consider several values. All are essential features of the basic principal of multiple land use.

Recreation is one of the nation's real social problems. As a source of recreation the forests have almost unlimited possibilities. Forests were America's first playgrounds, and the national and state forests have long been favorite recreational centers.

There are some economic and social values of forests which cannot be accurately stated in dollars and cents. Yet, these factors are significant. One major objective in forest management is to restore areas of low productivity to full productive use. Forests are closely related to problems of family income, standards of living and stability of local industries. Tax delinquency is greatest in regions which have been deforested. The management of our forests to provide continuous timber crops is essential to the economy of Texas. Lowered income in the commercial timber counties would be reflected in business conditions of the whole state.

Our present forestry program has developed from thirty-one years of experience and research. In 1915 the legislature of Texas created a state department of forestry under the jurisdiction of the Agricultural and Mechanical College of Texas. The new agency, known as Texas Forest Service, was given the responsibility of protecting, managing, and restoring the forest resources of the state.

Only a brief summary of the state forestry program is possible here.

Forest protection is one of the most difficult and expensive problems in any forestry program. Texas Forest Service is now protecting nine million acres in the East Texas commercial pine and hardwood belts. This is 64 percent of the area needing protection. Fire is forest enemy number one. One forest fire every four hours is the average for Texas. Ninety-nine percent of all forest fires in Texas is caused by man. We Americans know better, but we have not yet learned to behave intelligently toward fire. Preventing fires is the best method of controlling them.

Modern forestry depends upon research for unbiased, objective knowledge. The research forester, like other scientists, accepts findings as facts only when their accuracy has been proved. Silvicultural research includes studies of the adaptability of species to various regions of the state, growth studies, the effect of thinning, pruning and fire, nursery research, insect and disease control and tree killing methods. Forest products research is being carried on at our laboratory in Lufkin. One main objective is to find uses for some kinds of wood which now have little commercial value. Another objective is to develop more efficient utilization of many kinds of wood and wood products. Knowledge acquired by research can contribute much to the problem of land use planning.

Scientific knowledge can be useful only when it is applied. The forest management phase of the state forestry program is concerned with helping landowners practice good forestry. Many timber operators are now profiting from the advice and technical assistance of foresters. Special attention is given to selective cutting, marketing and fire protection. Approximately three million acres of industrial forest land is now subject to improved forest practices. The "tree farms" system which is a part of the farm forestry program now includes one hundred tree farms comprising a total of nearly two million acres of woodland.

Reforestation is another major problem in forestry. In East Texas more than 1½ million acres of cutover pine and hardwood forests have very poor reproduction. A federal report prepared in 1945 indicated that 573,400 acres in East Texas were considered plantable. Reforestation may mean complete replanting of areas from which all trees have been removed. More often reforestation is concerned with restocking areas to improve the stand. Sometimes planting is necessary to establish reproduction when insufficient seed trees are left. Reforestation must depend mainly on natural reproduction which will reclaim much ruined timber land if the young trees are given the necessary protection.

The Indian Mound Nursery near Alto was established by the Texas Forest Service in 1940. Here several million pine and hardwood seedlings are produced annually for distribution to farmers and industries.

The interest in tree planting in Texas is increasing. Nearly two million seedlings were planted in East Texas in 1945. This year the demand for seedlings far exceeds the available supply. It is contemplated that production of seedlings will be increased to 15 million by the 1947-48 season.

In addition to forest protection, forest management, research and reforestation, Texas Forest Service has long regarded education as a function of the state forestry program. Education seeks to create an intelligent attitude toward the use and restoration of our forests.

# SUPPLEMENTARY SOURCES OF PETROLEUM PRODUCTS

Harry H. Power*

Accelerated interest in the development of substitutes for petroleum has been evidenced in recent years, prompted primarily by the popular conclusion that "something had to be done" about our declining reserves of crude oil, especially in times of national emergency. Among the most probable sources of such auxiliary reserves are: coal, oil shale, tar sands, natural gas, and agricultural products. Although the cost of producing substitutes for petroleum may be prohibitive under ordinary peacetime developments, a national emergency may justify the exploitation of these reserves if only to supplement the increased but temporary demand. The additional man-power, equipment and time element necessary to establish satisfactory processes and products are practical problems for which adequate plans must be prepared well in advance of an emergency.

The problem is essentially an economic one and will depend on the availability of crude petroleum either at home or abroad at current or higher prices. These auxiliary reserves under peacetime conditions will not be available until substitute products are obtained from them at no greater price than is paid for the corresponding products from crude petroleum.

All other considerations being equal, the less the number of steps through which the raw materials must pass in their transformation into gasoline and other finished products, the simpler and more economical will the manufacturing process become. If liquid fuel is to be processed from coal, for instance, the latter may first be converted to a hydrocarbon liquid by the involved and costly process of hydrogenation. The cost of making hydrogen alone for this process is an important item. This product must then be separated into desirable and undesirable fractions and further refined. Hence, petroleum as a source of gasoline is two steps ahead of coal in the process described.

The date on the several processes which has been gathered from various sources to date is far from complete, although material progress has been made in only the past few years to bridge the gap between pilot and full-scale plant operations. Extensive pilot plant research has been conducted with respect to the hydrogenation of coal, and the modernization of the original Fischer-Tropsch synthesis. The data on the older European operations are inadequate for the purpose of projecting commercial operations in this country. Shale-oil research on a greatly accelerated scale is under way, but the extrapolation of old plant data does not result in estimates in any manner comparable to the data impending from plants of commercial capacities. The yields and costs for the so-called "tar sands" operations need clarification and extension from further large-scale operations. Petroleum fuel substitutes from agricultural products play a minor role in the economic pattern in view of their relatively high cost.

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Although new material concerning methods and costs incident to the manufacture of substitutes from auxiliary reserves is not considered, yet an attempt is made to trace the development of each process broadly, and compare investments, yields and unit costs of production for the principal product, motor fuel, resulting from full-scale operations. The costs of substitute gasoline are only of broad significance since they do not include such items as transportation and the cost of marketing the by-products. The investment figures are only roughly indicative since it was necessary to compare plants of different capacities, some of which were obsolete. However, the data, such as it is, together with estimates of the reserves of source materials, present a broad picture which may be of assistance in forming at least a tentative conclusion concerning the relative order of impending competitive importance of the several processes.

Considering the various sources of raw materials, it is evident that the high cost of coal hydrogenation will bar the process from immediate consideration. Although the investment cost per barrel per day for the coal carbonization do not appear to be too large, yet the cost per barrel of gasoline as reported is still out of line with other processes. In addition, the immense quantities of coke, unless converted to other products, present a handicap to this operation. Although the presently known investment and operating costs for shale oil operations are high, full-scale Government operations impending will help to clarify their economic significance. The estimated reserves of shale oil in this country alone are of sufficient extent to be reassuring in a future emergency. Further development of tar sands, particularly from the standpoint of full-scale operations, should throw more light on their competitive importance, especially at distances away from such deposits, but closer to crude oil sources of supply. Locally, tar sands appear to be competitive with local sources of gasoline from petroleum, especially in Alberta.

During the past few years great interest in the synthesis of gasoline from natural gas has been shown by the oil and gas companies. The efficiency of the Fischer-Tropsch synthesis, implied from the yield of gasoline, is low, since only about 40 percent of the heat content of the gas charged to the process is recovered in the liquid product. Conversion of coal is said to be less efficient than the conversion of natural gas. However, further research will continue to improve these efficiencies materially, with large-scale synthesis from coal economically possible, after the preliminary full-scale pioneering with natural gas has been demonstrated fully. Although natural gas may become competitive with crude petroleum as a source of liquid fuels in the near future, it is doubtful whether an ultimate solution has been reached.

Modifications of the Fischer-Tropsch synthesis from natural gas will find interesting application, particularly where it can be combined with other processes or with existing facilities. For instance, the production of natural gasoline and the manufacture of chemicals present one opportunity for such a combination. The success of the development brings new problems of integration with the natural gasoline industry. It affords an outlet for residue gas and for dry gas without a pipeline market. Furthermore, it promises to compete with the natural-gas fuel industry for this gas. As higher price markets for natural gas are developed the present low price markets will disappear. Hence, it is believed that our natural gas resources will not be exhausted prior to those of crude oil.

If, as Oberfel has stated, we doubled the efficiencies of oil recovery, doubled the yield of motor fuel from crude oil, and doubled the efficiency of utilizing the fuel in the engine, one barrel of oil reserves could be made to last as long as eight do at this time. Hence, our present known reserves of oil would last 100 years instead of the present estimated 15 to 20 years. More chances appear for research to develop entirely new sources of energy or to make the energy available in present fuels more efficient. A surplus of crude oil might exist under these conditions rather than the present prospect that our petroleum resources will be exhausted in less than a century.

It is essential that Government and other research programs concerned with petroleum should be encouraged, since the life and amount of our petroleum reserves will be extended accordingly. The present research on our auxiliary sources of supply is a complimentary and necessary program. It is quite possible that research on the conversion of coal and natural gas and other source materials will have a primary application and benefit to the petroleum and natural gas industries in that the latter, because of this research, will be enabled to manufacture more and better fuels and lubricants.

# THE WILD TURKEY—TEXAS' GRAND GAME BIRD[1]

Walter P. Taylor, Leader
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At a previous meeting of the Texas Academy of Science (Proc. and Trans. 1943 27:231-232, 1944) I discussed the origin and relationship of the wild turkey. At this session I am presenting information based upon a study of the bird conducted on the Edwards Plateau of Texas by the Texas Game, Fish and Oyster Commission in cooperation with the Texas Cooperative Wildlife Research Unit and the Texas Agricultural Experiment Station.

Originally found in 38 states of the Union, the wild turkey, by the year 1920, had disappeared from 18, and remained in 20. At the present time the species occupies not more than 28 percent of its original range in the United States. (THE WILD TURKEY IN VIRGINIA, Mosby and Handley, 1943, p. 21.)

Among the wild turkey states of the Union, Texas is favored. A wild turkey survey was conducted by the Texas Game, Fish and Oyster Commission in the fall of 1945. This included all counties in the state known to have wild turkeys. At that time an estimated population of 65,000 to 73,000 individuals was found in 29 counties of the Edwards Plateau region. In 44 additional counties, outside the Edwards Plateau, there occurred an estimated 32,000 or 33,000. This is a grand total of about 100,000 of the birds in the State, 69 percent in the Edwards Plateau region, 31 percent in other areas. About 73 Texas counties, or 28 percent of the total of 254 counties within the State, now possess smaller or larger stock of these game birds.

In 1941-42 such scattered records as we have indicate that about 8,000 turkeys were taken by hunters. It is altogether likely that more than this number are harvested each year, but the figures are not at hand to show it.

Obviously the largest wild turkey area in Texas is the Edwards Plateau, where a continuous tract including at least the 29 counties mentioned above is occupied by the birds. The next largest is in South Texas where, on and in the vicinity of the King Ranch area, there are 5 counties containing many of the birds. East Texas has the third largest area. Unfortunately, in this part of the State the birds are extremely scarce. Others are scattered, usually in small groups, in suitable territory in the Texas Panhandle, the Rolling Plains, the Coastal Prairies and the Western Mountains.

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[1] Cooperating in this work on the wild turkey in Texas are: Harold L. Blakey, now with the Corps of Engineers, U. S. War Department, Vicksburg, Mississippi, formerly with the Fish and Wildlife Service, U. S. Department of the Interior; Henry C. Hahn and Eugene A. Walker, Texas Game, Fish and Oyster Commission, the former at Kerrville, the latter at Menard, Texas.

[2] The Fish and Wildlife Service, U. S. Department of the Interior; Agricultural and Mechanical College of Texas, the Texas Game, Fish and Oyster Commission, and the Wildlife Management Institute, cooperating.

Fluctuations in wild turkey numbers from year to year are very great, but so far as published and accessible figures go, the total wild turkey population in the State would appear to have remained fairly stationary for some 18 years. During this period there have been some noteworthy extremes both ways. Unfortunately accessible figures are incomplete and may even be misleading. There is a widespread and doubtless authentic feeling that wild turkeys are becoming fewer in number, decade by decade.

### Wild Turkey Hunting on Shooting Preserves

Turkeys killed per 100,000 acres on the 2,094,117 acres of shooting preserves varied from 30 in 1939-40 to 164 in 1931-32. Successive years show great differences in the number of these birds killed per hunter per 100,000 acres. Thus from 1938-39 to 1939-40 the number dropped from .196 to .004; that is, individual hunters procured 49 times as many turkeys per 100,000 acres in 1938 as they did in 1939.

Obviously these figures convey no information on the reasons for the wide fluctuations in the numbers of turkeys. It is altogether probable, however, that climatic factors had more to do with the wide fluctuations in wild turkey numbers than did the numbers killed by sportsmen.

It is of interest that over a 13-year period 23 percent of all wild turkeys killed on shooting preserves in the Edwards Plateau were killed in a single county—Gillespie; 47 percent of all wild turkeys killed on shooting preserves were taken in Gillespie and Kerr Counties together; 57 percent in Gillespie, Kerr, and Medina; 67 percent in Gillespie, Kerr, Medina, and Mason; and 87 percent in the highest seven counties including Gillespie, Kerr, Medina, Mason, Kendall, Kimble, and Bandera; 13 percent of all wild turkeys killed on shooting preserves were taken in the lowest 14 counties in which turkeys were reported killed; in 12 of the 33 counties making up the Edwards Plateau no turkeys at all were reported killed on game preserves.

### Original Conditions

In the early days wild turkeys appear to have been decidedly more abundant than they are at the present time. In 1847 Uncle Jesse Loving of Sherman, Texas, lived on beef, venison, turkey, antelope, and bear. In the early days the range was very different in appearance from what it is at the present time. Bentley (Farmers' Bulletin, No. 72, 1898, pp. 6-7), reported that in 1867 grass was from 1 to 3 feet high, and "there is little doubt that the ranges would have supported

300 head of cattle to the square mile." Thirty years later the carrying capacity of the range in this part of the state was down to 128 animal units per square mile, and by 1898 had declined to 64 or even to 50 animal units.

Everybody knows the livestock industry in Texas has grown substantially and rapidly. The first cows were brought in to a Spanish mission established near the Louisiana state line in 1690, where a herd of 200 was kept. By 1767 wild horned cattle were reported west of the Brazos river. Between 1903 and 1944 (a period of 41 years) the number of sheep and lambs increased from 1,740,000 to 10,220,000, or nearly sixfold. Similarly, between 1909 and 1943 (a period of 34 years) the number of goats increased from 1,125,000 to 3,660,000, or more than three times. In 1943 Texas mohair made up 87.2 percent of production in the entire United States. In Central Texas cattle have remained about the same in numbers for the last few years. Obviously and inevitably the coming of the white man's herds of livestock has affected all forms of range and forest wildlife, including wild turkeys.

## Critical Period

One of the most critical weather factors in the life of the wild turkey is drouth, which is most likely to take place in June, July, and August. Probably almost as bad are cloudbursts during late spring when the turkeys are nesting. Much less harmful are hail and general rains which, in the long run, may do as much good in encouraging the growth of turkey feed as harm in drowning and injuring the young turkeys.

## Flocking

Between 1937 and 1942 more than 792 flocks of wild turkeys were checked. Of these 130 (32 percent, 2,512 individuals) were flocks of gobblers and hens together; 545 were flocks of gobblers or hens alone or separately (68 percent, 5,196 individuals, of which 218 flocks (including 1,414 birds) were made up of gobblers exclusively, while 327 flocks (made up of 3,782 birds) were composed exclusively of hens. In 117 of the flocks (including 3,545 individuals) the sex of the component birds was not recorded.

Wild turkey flocks are largest in mid-winter (December and January); they decline in the spring and remain small through the summer.

## Broods, Poults and Hens

Between 1937 and 1945 studies were made of 320 broods of young wild turkeys, totaling 2,872 poults. Average poults per hen, including total number of poults divided by the total number of hens with them, was 4.7 (3.3 to 15.5). Average size of broods (total poults divided by number of broods) was 8.9 (5.2 up to 13). Of the broods observed, one was seen in March, 8 in April, 27 in May, 271 June to September, 13 in October-November-December.

Broods began to decrease in size almost as soon as they appeared. As might be expected inimical factors begin to operate as soon as the birds are hatched. In size broods varied from 1 to 40. Very often several hens were observed with flocks of poults, indeed from 1 to 15 hens were seen with various groups of the young birds.

### Fate of Wild Turkey Nests

Of 117 nests examined between 1937 and 1945, 5 were deserted, 10 hatched, the fate of 32 is unknown, and 70 were destroyed by predators or otherwise. Of 70 destroyed, 3 were destroyed by some unknown factor, 4 by snakes, 5 by birds, and 58 by mammals. The fate of 576 eggs was recorded as follows: 230 (or 40 percent), unknown; 260 (45 percent) destroyed; 86 (or 15 percent) successfully hatched. Losses were probably normal. Assume that each pair of wild turkeys must replace itself in six years to maintain numbers of the species. A turkey hen will lay an average of 11 eggs a year, or 66 eggs in six years. If all of these survived there would be a 3,200 percent increase. According to Leopold, a species bearing its first young at the age of two years and producing 10 young would produce 602 individuals at the end of six years (410 young, 110 year-old birds, and 82 adults). In other words, if it were not for the numerous inimical factors wild turkeys would be so numerous there scarcely would be standing room for mankind!

### Laying, Incubation, and Hatching

Data on 29 wild turkey nests show that laying began on March 27, reached its height May 1 or 2, and decreased to June 5. On April 4 incubation began, reached its peak May 25, and was completed by July 3. The earliest hatching date was May 10, the last July 4. There is a poorly marked double peak in hatching, first around May 31, and the second about June 25.

### Artificial Feeding

For at least 20 years some of the ranchmen in the Edwards Plateau country have fed wild turkeys to hold them on their ranches. Of 187 ranchmen who replied to a questionnaire, 84 (44 percent) fed turkeys, while 93 (56 percent) did not feed the birds.

Experiments were carried out to determine some of the advantages or limitations of the practice. Our tests showed the best feed for wild turkeys was yellow corn, with milo, wheat, and oats following in that order.

Feeding wild turkeys has all the disadvantages of baiting. It lessens the wildness of the birds and encourages too large a take during the hunting season. On the other hand, it does permit selection of birds in shooting, and alarms birds less than other forms of hunting. Obviously the practice almost entirely eliminates the elements of field sportsmanship and woodcraft from the pursuit of wild turkeys. On some of the large ranches extensive feeding operations for livestock made involuntary feeding of wild turkeys inescapable.

We found that if wild turkeys were consistently and generously fed, using yellow corn or milo maize, beginning not later than September 15, the birds remained even in the high Divide Country of Kerr County. Otherwise they might move for a considerable distance into the river courses where more natural feed is available.

In addition to feed, it was necessary to provide an abundance of water for the turkeys, and it was also essential that there be at least some natural feed. Suitability and nearness of roosting sites were also important. There must be plenty of shelter for nesting, if these birds are to do well. Also there must be careful regulation of shooting. No hunting of wild turkeys should be done at their roosts or at their feeding stations.

### Natural Foods *

Analysis of 65 crops and two gizzards, mostly taken in hunting season, showed food items as follows:

| Food | Percent | |
|---|---|---|
| Acorns | 23.85 | |
| Sumac (several kinds) | 18.25 | |
| Cedar elm | 8.99 | |
| Insects | 8.20 | (grasshoppers, crickets, cockroaches, beetles, moths, skippers) |
| Johnson grass and sorghum | 8.19 | |
| Domestic oats and misc. grasses | 5.00 | |
| Sporobolus | 2.82 | |
| Wheat | 2.80 | |
| Corn | 2.55 | |
| Juniper | 2.24 | |
| Hackberries | 2.00 | |
| Galls | 1.34 | |
| Doveweed | 1.26 | |
| Unidentified and scattered items | 5.53 | |
| | 100% | |

Blakey, Hahn, Walker and the writer are now preparing for publication a comprehensive paper on "The Rio Grande Wild Turkey in the Edwards Plateau of Texas."

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* Blakey (in manuscript) has shown that 479 species and 46 varieties of plants native to the Edwards Plateau constitute potential food resources of the wild turkey.

# COORDINATED SOIL CONSERVATION

By Paul H. Walser *

In selecting my topic for today, I made my decision in the belief that in the title, "Coordinated Soil Conservation," I am referring to the thing that is the core, the essence of all our effort to save our topsoil from erosion and depletion and to gain from it the most efficient production of the crops that mankind requires in his plan of life.

It is my intention to explain to you why we in the Soil Conservation Service emphasize the term "coordinated," why the success of the work we are doing depends upon how well the principle of coordinated soil conservation is put into practice upon the land. I also want to explain briefly the organization which landowners have created for the purpose of establishing a kind of soil conservation which will keep our nation strong.

The practices used in soil conservation must be based upon the best scientific knowledge available. We can be satisfied with nothing less as technicians lend their skill to the soil conservation districts and to the farmers themselves. Nothing less would be adequate. Only cursory study will prove that soils vary widely. Soils are much like people in the number of characteristics which distinguish them. The productivity of any soil, the ability of any piece of land to produce something of value to mankind, depends upon many factors; and these are factors that we must know, as a physician diagnoses an illness, when we set out to prescribe a treatment or an occupation for that land.

In applying soil conservation to the land, there is no adequate substitute for the precept that every acre of land should be treated according to its needs and used according to its ability to produce safely the crop or crops for which it is suited. It is only in comparatively recent years that we have begun to learn the full use of coordinated practices in the scientific approach to the conservation problem. In these few years the scientists of soil conservation have developed important practices which are contributing greatly to the work.

The testing of grasses to provide longer grazing periods, the introduction of legumes which provide cover for erodible soil and at the same time revitalize the soil for new crops, the development of methods for building terraces and terrace-diversions, the testing of grass seeding methods and mesquite eradication, stubble-mulching to reduce the cutting effect of the wind—all these are projects upon which the skill and knowledge of conservation scientists have been brought to bear. The success which has attended these scientific explorations in soil conservation has been written on farm ledgers in figures that add up to many millions in added farm income and a much higher

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* Texas State Conservationist, USDA Soil Conservation Service, Temple, Texas. Paper to be read before meeting of Texas Academy of Science, Dallas, Texas, December 1946.

level of morale among the millions of our farm population. The value of this work in land saved is beyond estimate.

But all of our scientific experimentation and discoveries are of no value unless we are able to get the needed practices in soil and water conservation applied to the land. That brings us to the consideration of the human factor in soil conservation.

I have in mind just now a certain farmer, an intelligent man who always has felt a deep responsibility to the land he owned. Twenty-three years ago this man bought a small farm which had long been exposed to water erosion so that it was scarred with gullies and the crop yields were such that a meager living at best was all the farmer could hope to get out of it. This man realized at once that he must do something if he were to keep his farm at all productive, since it was slipping away from him with each rain. At that time there was no systematic approach to the soil conservation problem—there were no Soil Conservation Districts or Soil Conservation Service technicians to aid him. But the farmer set out to do the best he could. He tried various measures and one of the measures was terracing. We have learned much about terracing in recent years. We know that terraces can be built improperly so that they will do more damage than if there were no terraces at all. We know some of our land here in Texas does not permit terracing, that it virtually dissolves as would sugar when the rain falls. We know that terraced land must have organic matter in order to retain moisture as it should, and we know that vegetated waterways, contour cultivation, the use of cover and soil-improving crops, strip-cropping and crop rotation are important, too, in the protection of land that is to be terraced.

But the farmer was doing the best he could and the terraces he built at least helped to slow the run-off which had been taking away his soil.

This man, who had studied his problem and who wanted to save his land, became a coordinated conservation farmer a few years ago. And this is what he had to say recently:

"You need more than terraces. They're good as far as they go and they are necessary in this rolling country to hold water back. But you've got to have other things too. You need fertilizer, soil-improving crops; and you have to have rotation. You perhaps need to take some fields out of cultivation altogether and put them into pasture, or it may be best to put some of your land in woodland for its protection and most efficient use. In short, you need a balanced program, a coordinated program of soil conservation. Nothing less than that is good enough for your farm."

That farmer's land last year produced four times as much corn as it did before he became a conservation farmer. His cotton increased from a half-bale to the acre to a bale. His 20 dairy cows graze on developed pastures and are a source of steady income. His farm operation is economically sound. Each acre of his land is contributing in some degree to his income. He not only is not losing his soil any longer, but his land is gaining with each year in its ability to produce.

I could show you entire communities whose scale of living has been elevated by the adoption of measures bringing into proper and profitable use each acre of the farmland which had veen vanishing with every rain and declining in fertility with each crop. This was not accomplished by means of contour cultivation alone, or rotation or fertilization or of soil improving crops. It was brought about, on the other hand, through the careful study of each acre of each tract of farmland contributing to the economy of those communities, through the application of measures dictated by the needs and capabilities of the land and fitted to the needs of the people who lived on and by the land.

The most effective way yet devised for accomplishing this objective is the soil conservation district. Districts are brought into being through the vote of the farmers themselves and are operated within their locally established boundaries by the farmers through their chosen officers.

In these districts, farmers are working together toward soil conservation and good land use. The formation, control and operation of the districts are democratic, from the first step of circulating a petition for a referendum, through voting in the referendum, to the election of district supervisors after a majority of the farmers have voted for establishment of a district.

Inasmuch as farmers own and control the land needing conservation, they themselves should have the final decision as to the work carried out on their land. They themselves should direct the program. In so doing, they accept the responsibility of the program and, having accepted it, grow to understand its value and to appreciate the need for continuing the work as long as they operate the land.

Since 1937, soil conservation district laws, or laws that permit a similar operation, have been enacted by all 48 of the states and by Puerto Rico. Since the state conservation law in Texas was enacted in 1939, 143 soil conservation districts have been organized. Others are in process of organization. These districts cover approximately 80 percent of the land area of Texas.

The state conservation law in Texas provides for the election by the landowners of a State Soil Conservation Board which is made up of five men representing five more or less equal geographic subdivisions of the state. The law stipulates that these men shall be resident landowners of the subdivision of the state which they represent and that they shall be actively engaged in the business of farming or of animal husbandry. No one may participate in the election of these men except landowners.

This board administers the state soil conservation program in Texas, and this is the way it figures in the business of soil conservation in our state: First, before a soil conservation district can be organized, the state board must receive a petition signed by a minimum of 50 landowners, or a majority in case there are fewer than 100 landowners involved. This petition requests a public hearing on the question of forming a soil conservation district in a specified territory. In this hearing the state board seeks to determine whether there is a need for a soil conservation district, whether the local people want it and whether they are sufficiently interested to operate it after they get it.

These questions being answered to the satisfaction of the board, a referendum is granted, in which landowners—and only landowners—may vote for or against the organization of a soil conservation district. If two-thirds of those voting favor the forming of the district, the next step is the subdivision of the district into five geographical parts and the appointment of two landowners, followed by election of three others, each representing one of these parts, to comprise the district board of supervisors. The Secretary of State at Austin issues a Certificate of Organization to this board.

The development of a program and a plan of work is the first major responsibility of the district board of supervisors. The program describes the actual conditions existing in a district in relation to the land and its use and how the problems may be solved. In the detailed plan of work, the owners of the land indicate what they want done about the problems they have set forth in the program.

The plan of work is forwarded to the Soil Conservation Service, which enters into a supplemental memorandum of understanding with the district's board of supervisors. Any other federal agency may enter into such an agreement. State agencies in a position to help also are committed by the state law to assist the district boards.

There are a number of agencies, of course, from which a soil conservation district may request assistance. The Soil Conservation Service, however, is the agency which channels virtually all its resources through the medium of the soil conservation districts.

I explain this procedure because it helps to emphasize my assertion that the soil conservation district, a political entity established for a definite purpose, is the most effective means of getting soil conservation on the land and keeping it there. Our experience has proved that we are right in this belief.

The soil conservation districts have been adhering in their work to these basic principles: (1) use each tract of land for the purposes that it is best adapted (things it is best suited to produce); (2) improve the soil, so that its ability to produce will increase; (3) get more water stored into the ground by checking runoff and control the runoff so that it will do the least damage possible to the land; and (4) develop on each farm unit a program that is economically sound.

Experience has shown that the resources of the Soil Conservation Service, or any other assisting agency, can be transmitted with greater effect to the land through groups of farmers who have signed agreements with the supervising boards of their soil conservation districts. Such groups of cooperators permit the economical use of available equipment, the solution of joint problems such as water disposal and terrace systems, the purchase of seed and fertilizer in large quantities. They build up among themselves an enthusiasm for the program and pride in personal achievement.

Each farmer accompanies a farm planner over his acres, discussing with the technician his problems in cropping and his reasons for preferring either this or that use for a given tract. They study the depth, texture, permeability, content and erodibility of the soil. These factors are important in arriving at a plan for the permanent protection of the topsoil and the continuing improvement of the soil. The farmer then decides upon a plan based on the capabilities of the land and its needs, taking into consideration his own economic requirements.

Progress in applying soil conservation in districts is rapid, greater than ever before. But the area of our available cropland is shrinking still although our population continues to grow. The day is not far off when these two curves may meet. When and if that day comes we no longer will be able to produce more than we need within our own boundaries.

If we are to remain a vigorous nation, we must make certain that our most precious natural resource, our soil, remains to sustain us. This we can accomplish through the application of coordinated soil and water conservation measures to all our land. We must study our land so that we know its qualities and capabilities as a merchant knows his merchandise. We must guard it against theft by wind and rain. We must replace it in the fertility which we remove by cropping and restore the soil that has been abused.

Only a coordinated program of soil conservation is equal to this task, a program which takes into account the many and varying needs of the soil and of the people who live on it. I would like, therefore, to apply the term "coordinated" in an even broader than usual sense to include this on additional extremely important element, namely, the informed, active participation of all people in the achievement of this great objective—the saving of our soil.

## SOME OBSERVATIONS ON CONSERVATION OF MAN

By L. S. PAINE, Department of Agricultural Economics
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Volumes have been written on the subject, "Conservation of Man." One issue, however, has never been clearly stated—What is involved in human conservation? And, what is perhaps more important: Why conserve man? What is the goal? These questions should be clarified, otherwise we will be in the same class as the man who got on his horse and rode rapidly away in all directions.

Conservation of man involves both his physical and psychological well-being. Physical well-being is a matter of bodily health, including mental condition, because mental illness results from diseased organisms within the body. Psychological well-being refers to human attitudes—the attitude toward himself, his neighbor, his nation and his world. Upon his attitude will depend his reactions to programs designed to improve the status of the individual, as well as society. A proper psychological attitude is essential to successful living, in the broadest sense.

What is the goal of human conservation? Is it the development of perfect physical specimens of mankind who have undoubted loyalty to themselves and their neighbors, men and women who may become the world's finest soldiers? This apparently was the aim of the Nazis in their human conservation program. It is doubtful if, even in the unchristian world of today, this goal can be justified. A more vital reason for human conservation must be found and it may be found in the religious philosophy of living. Conservation of man, therefore, must aim toward promoting the fuller life, to the end that the individual may live long and be happy and assist others in the same direction. This includes both the physical and the psychological man.

### Physical Health

So much has been written about general health conditions in the United States that it is unnecessary to elaborate on that subject in this paper. Medical science has controlled some diseases while others are rampant. Some diseases are spectacular and their control has received popular support. Others, which do not kill outright but which are very costly in terms of human efficiency, apparently receive little attention! The common cold is an illustration. It appears that medical practice is more concerned with treating disease than in preventing it.

During recent years, many scientists, led by a small group of visionary doctors, have become quite disturbed over the increasing prevalence of a number of destructive diseases. Bacterial diseases commonly increase as a society grows older; this is an accepted principle in the biological world. Another group of diseases is associated with deterioration of body tissue, and it is this group which is coming into the limelight. Some diseases such as dental caries, rickets, osteomalacia, pellagra, arthritis, diabetes and numerous ailments of the circulatory system are included. They are evidence of evolutionary degeneration, a surprising and shocking condition in this day of enlightened science. It appears that our nation is becoming a nation of chronic invalids.

The diseases mentioned, as well as others, make no distinctions among classes of people, in fact, they seem to have an affinity for the more civilized groups. Some, such as dental caries, are virtually non-existent among primitive peoples, while examinations made in the public schools in the United States reveal that 85 to 100 percent of the children are afflicted with dental decay. [1] Rickets has little respect for social class or income group. Strangely enough, this disease is most common in areas which it is least expected, namely, in the South where climate permits outdoor activity most of the year and fresh vegetables are available throughout the year.

The national aspect of the health program is indicated by an analysis of Selective Service records. [2] A two-year study of the nation's health by a United States Senate subcommittee on Wartime Health and Education has revealed that of more than 14 million men examined for the draft, only 2 million were up to standard. About one of every six citizens of the United States, the subcommittee reported, has a chronic disease of physical impairment. A later report states that approximately 12 percent of all those examined by the armed services were found mentally unfit for military duty. During the period November, 1940, through September, 1941, of approximately 3 million men registered in 16 selected states, the rejection rate was 52.8 percent.

The records quoted above indicate an alarming health situation. A number of scientists, including medical men, have asked themselves the question—What causes diseases of degeneration? While there is no agreement to date, many investigators believe that these diseases are caused by nutritional deficiencies. In some cases, such as scurvy, pellagra and rickets, the relationship is definite, in others it is suspected. But why should people who live in a sunny climate where vegetables grow throughout the year suffer from rickets? The logical answer is that the vegetables lack the necessary food values to maintain health because they are produced in soils from which plant foods have been removed, either through continuous cropping or by geologic leaching. Obviously, depleted soils cannot supply plants with minerals and man cannot be sustained by plants which do not contain the necessary minerals and vitamins. A chain of health relationships is thus established.

Evidence that soil depletion may be responsible for the national deterioration of health in the United States is not conclusive, however, the relationship appears to be acknowledged by a growing number of scientists. The Medical and Panel Committeee of the County of Cheshire in England has reported the results of 25 years of study of health conditions in Cheshire County, and attributed the alarming increase of illness to "a life-time of wrong nutrition." [3] Dr. McCarrison, in India, fed rats with the same diets as eaten by people in various parts of India and in each case produced in the animals a state of health corresponding to that of the people. Dr. Clarence Mills, of the University of Cincinnati, in his book, "Climate Makes the Man," illustrates the relationship between soil conditions and the food value of products of the land. While he emphasized conditions in the wet tropics where soils are conspicuously leached, he brought out very clearly that vegetables raised on the leached soils of the Gulf Coastal plain of Texas are not capable of nurturing either man or animal. Unfortunately, this condition is not restricted to the Gulf Coastal area. Throughout the humid parts of this country, the experiment stations are working on the problem of mineral deficiency in soils. Dr. Wm. A. Albrecht, of the University of Missouri, has done outstanding work in this field. He has suggested that our nation is "starving to death," even though many maintain what is normally considered a balanced diet. The essential food elements are not present and, though the eater may have a feeling of fullness, he is still hungry. Eventual consultation with his doctor proves futile because there is nothing physiologically wrong—he is merely hungry. Is it any wonder that quacks and patent medicines flourish?

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[1] Health From the Ground Up, K. B. Mickey, Public Relations Department, International Harvester Co., 1946, P15

[2] Ibid, P14

If the time ever comes when the American people eat to live, they will become very discriminating in their buying habits. Instead of simply buying spinach, they will demand spinach from the Southwest or West where soils still retain much of their original mineral content. They will refrain from buying vegetables from regions of poor soils unless the plants have been properly fed with fertilizers. The same will apply to livestock products. The way to health, as far as diseases of degeneration are concerned, is being blazed. This all-important aspect of human conservation must be recognized and dealt with summarily if the American nation is to retain its proper place among the nations of the world.

## Psychological Health

The goal of human conservation, from the point of view of psychological health, is the creation of an attitude in the individual that favors a happy and prosperous society. Happiness and prosperity are basic components of democracy. Happiness, socially speaking, is promoted through individual freedom, freedom to think and act as training and fancy dictate. The individual who is free to follow his dictates will normally achieve at least a modicum of prosperity, especially in a country abounding with opportunities. Democracy permits these freedoms. It follows, therefore, that happiness and prosperity are promoted by democracy, and that democracy can thrive only where happiness and prosperity exist. Democracy, however, is related to the state of mind, or attitude, of the individual, an attitude which recognizes the privileges, as well as the obligations, of both the individual and society. The creation of this attitude becomes an essential part of a human conservation program and without it, democracy cannot long survive.

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[3] Ibid, P21

Science can, and probably will, ultimately discover how to control pathological conditions in the human system. Can it do as much for psychological man? This phase of human conservation appears to be much more complicated. The human mind does not lend itself to measurement, and reactions do not fit definite patterns. However, considering society as a whole, human mental reactions tend to follow definite lines with given stimuli. The thinking of society may thus be directed along desired lines through planned educational programs. While education neither begins nor ends in the classroom, nevertheless, the school system of a country becomes a powerful agent in shaping the philosophy of the people. Schools influence children during the most impressionable period of their lives, a period when philosophies are being developed. Inasmuch as the thinking of mature men is conditioned largely by experiences of youth, it is logical to begin a program of human conservation in the schools. All classes and groups will be influenced if the school program is national in scope. Ultimately, unity of action may be expected, a prime requisite for success. Only after man understands his social problems and recognizes his social responsibilities may we expect the ideals of democracy to be achieved.

What type of educational program would achieve the goals of human conservation? What changes in present curricula would be necessary? These questions suggest the basic difficulties in attacking the problems of human conservation through schools. Teachers and the field of education are conservative, so much so, in fact, that they have failed to keep pace with evolutionary social changes. Education still consists essentially of the teaching of the three R's, refined somewhat as to method, to be sure, but with a pathetic failure to include a study of real problems of life and living in the modern world. This criticism applies alike to secondary schools and institutions of higher learning. Vocational training, an aid in making money, is replacing education, an aid in living. Teachers are products of this type of learning so it is small wonder that they are incapable of imparting to their pupils and students an ability to visualize, and sympathize with, the social problems of the present. As evidence, consider the alarming increase in juvenile delinquency in this country within recent years. It is mute testimony to the fact that society is not alert to the needs of modern youth. Our schools teach how to make money but not how to spend it in order to preserve the psychological health of the nation.

Innumerable illustrations might be given as evidence that the

American people are unhealthy psychologically. All point to one basic factor: the failure of education to prepare students to meet current problems of living in a democracy. Students neglect the humanities in a fervor of zeal to become technically skilled. By so doing, they render themselves incapable of judging fairly the results of democratic processes. Today, our nation is plagued by strife between capital and labor, strife which weakens the very foundations of American democracy. The question is asked: who is to blame, but very seldom is reference made to the matter of justice. The average American does not think in terms of justice, instead, he thinks in terms of personal advantage. It is doubtful if even our courts can be truly considered as dispensers of justice; in far too many cases, decisions are rendered on the basis of legal technicality. Politics has largely displaced statesmanship in the field of government. Our leaders are products of modern education and it appears obvious that something is sadly lacking in our schools. Far too little emphasis is placed upon the art of living in a democracy, a weakness which must be overcome if our ideals are to survive.

A final illustration of the psychological deficiency of the American nation may be given. During the past four decades, the callous disregard for our resources, including man, has become more and more evident. All have been exploited, with a consequent weakening of our socio-economic structure. It is a natural response to the unrestricted use of resources in a sparsely populated area. Today, the ratio of resources to man is so low that we must regard resource utilization in the light of maximum social benefit. Land ownership must be regarded as a sacred trust, to be used but not abused. Otherwise, private property in land, in its broad sense, must surely pass into the limbo of the unknown. Here is a real social obligation of our schools—the creation of an attitude toward man and natural resources such that both may contribute to the prosperity and happiness of society. Conservation of man may thus be achieved.

# THE PART OF THE FISH AND WILDLIFE SERVICE IN THE WATER UTILIZATION PROGRAMS IN TEXAS

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During the busy war years just past we sometimes saw brief comments in the daily press upon a national program for utilization of water in this country. These statements were often rather general in nature and were usually to be found deep inside the Sunday editions. Since the end of hostilities shortages of materials and man power have limited construction to such an extent that only a very small per cent of the planned projects are under construction at this time. Hence, it may be that the general public is somewhat unaware of the scope and content of this vast program which is already rather definitely outlined.

In order that all water shall be put to the best possible uses, every major stream and most of the minor streams in the United States, its territories and possessions, have been under study for some years by one or more government agencies. In more humid regions the primary objectives sought are flood control, stream regulation for industrial and municipal water supplies, power production, and sometimes provision for navigation. In the more arid parts of the country, irrigation is usually the primary purpose in water-use plans and all other considerations are secondary, though they may be provided for. Other benefits sometimes derived from controlled waters are pollution abtement, silt control, and replenishment of underground waters. Benefits that may be derived from regulation of waters without interfering with the primary or secondary purposes are increased fish and wildlife yields and enriched recreational facilities. Some of these basin studies are in a preliminary state; some are further along; and in over 600 cases definite projects have been recommended by the U. S. Engineer Department, the U. S. Bureau of Reclamation, the U. S. Soil Conservation Service, the U. S. Indian Service, or by private interests operating under Federal permit.

Here in Texas we all know of the four dams existing on the Colorado River above Austin. Eleven more projects, at least two of which are already authorized for construction, are planned in this river basin. Four dams are in operation on the Brazos River and its tributaries, and two more are authorized in that basin. According to information contained in a beautiful little publication sponsored by the Trinity Improvement Association of Fort Worth, there are six existing dams and reservoirs on the Trinity River System. Five more are authorized, and twenty-four more structures, some of which are locks, are proposed.

We have all heard of Lake Texoma, a 90,000-acre reservoir on the Red River between Texas and Oklahoma. At present this is the largest reservoir in the Texas region. McGee Bend Dam, which is authorized for construction on the Angelina River in East Texas, will impound a maximum lake of 186,600 surface acres, or over 291 square miles.

Five Texas counties, Aransas, Delta, Morris, Rains, and Rockwall, are smaller than this and Franklin County is one square mile larger. Evidently, Texas will be changed from a land of "more rivers and less water" to a land of lakes and regulated streams.

The type and extent of existing fish and wildlife habitats over much of the state will be changed by these developments, and great areas of new aquatic habitat will be created. The import of this to fish and wildlife can hardly be over-estimated.

Because of the importance of the areas that may be destroyed or affected by the developments, the Fish and Wildlife Service, as the national representative of the conservation interests of the country, recognized the need to take the lead; to seek the help of the several states in the study of the development plans; to find means to lessen fish and wildlife losses; and likewise to propose methods which would improve such resources. Authority for doing this is found in the Coordination Act of 1934 (48 Stat. 401) and is now very clearly strengthened by a revision of that Act, approved August 14, 1946, and entitled, "An Act to amend the Act of March 10, 1934, entitled "An Act to promote the Conservation of Wildlife, fish and game and for other purposes." This Act is based on a broader and more rational idea of the totality of our national resources and shows expression of the Congress that public interest requires that reservoirs be planned to serve multiple purposes, including those of fish and wildlife resources. Under this new law, the Fish and Wildlife Service is charged with investigating all Federal water-utilization projects, and those of public or private agencies under Federal permit, to determine sources of damage to fish and wildlife resources, and to determine all possible means of preventing such damage and of enhancing existing values. This law also specifies that no Federal agency may construct an impounding or diversion project without first having plans and programs studied by this Service and the appropriate state conservation agency.

In considering this problem, the Service is not entirely interested in the esthetic importance of the fish and wildlife resources of the Nation, but takes a practical point of view to determine what effect these developments will have upon the economy of the Nation. Such a practical approach is necessary under the surrounding circumstances. The basis for this statement is that the river developments planned by Federal agencies are measured in terms of money. Their projects cannot be sanctioned unless they show every evidence of being financially sound investments. Therefore, in order that the findings arrived at by Fish and Wildlife Service can be expressed in understandable terms by the sponsors of the projects and by the Congress of the United States, the Service puts its findings in terms of dollars and cents.

At the beginning of the work, one of the most difficult problems was to lay down a sound basis for the monetary evaluation of sport fish and game. There were almost unlimited variations in personal opinions and also wide regional differences. Commercial fish and fur animals offered less difficult problems. Such literature as was available on these subjects was studied. The game departments of the states were asked for their advice and statistical support for the values estimated by them. The guiding rule used in setting up these values was the average annual harvest per acre or mile of stream and the cost to sportsmen of taking game and sport fish. For commercial fish, the primary sale price was used. The values thus arrived at are used as the base values by the field biologists, with instructions to change them as local conditions warrant. As our field experience and the variety of work conditions increase, the base values are modified, but it is an interesting fact that the values laid down at first hold up exceedingly well in the face of criticism. By the same token, as experience increases, techniques are improved, more skill is displayed, and more assurance is felt in results obtained. Likewise, our vision as to the future uses that can be made of reservoirs and of adjacent land areas by fish and wildlife are expanding. Usually greater utilization can be brought about by changes in plans of operations or by additions to the developments as originally planned. Changes and additions may involve the inclusion of adjacent lands in the projects, planting programs, the creation of sub-impoundments, and water level controls during spawning season for fish and nesting and migration seasons for waterfowl.

The pre-impoundment evaluation requires a census of the population of fish and game, determination of the annual yield of all important species, both game and commercial. The post-impoundment evaluation demands a most careful study of the engineering plans to determine the probable conditions after the reservoir is built, so that the future yield can be estimated.

In arriving at a value for the fish production for a reservoir a graph is used which estimates the proper value of the average impoundment of a given acreage. The values used in drawing this curve have been found by multiplying the annual yield of 51 lakes and reservoirs by the estimated value of the species of fish. Certain limits are allowed for making the values higher or lower, if the reservoir promises to be an unusually good or poor producer of fish.

The Service's recommendation on each project is determined by the net effect on fish and wildlife, whether a loss or gain in dollar value.

In addition to the studies of the immediate areas to be flooded, investigations are made on lands to be irrigated, on streams below dams. The latter includes consideration of the seasonal downstream flows, the volume of water released, and the manner in which it is released. In considering the effects on fish and wildlife on irrigable lands and the ditches that service them, notice is taken of probable benefits or damages to fish and wildlife that will result from the use of the canals. There is also taken into account effect on habitat by silt, oxygen content, salinity, pollution, temperatures, and other conditions.

Supplemental fish and game data are obtained from various sources. Some of the most valuable are those of the State conservation departments, state universities, and Government agencies, such as the Forest Service, Soil Conservation Service, and the Indian Service. Other fruitful sources of information are the State geological, water, park, and historical agencies.

The Fish and Wildlife Service always seeks and receives full cooperation from officials of the State conservation departments, who are invited to participate in the field investigations. Upon completion of field reports, they are reviewed with State conservation departments and with the sponsors, in order to be sure that the coverage is accurate as to basic material obtained from them and that they are consistent with the State's responsibilities in the matter of fish and wildlife.

After the reports have been reviewed in the field, they are likewise reviewed by the several Divisions of the Service in the Central Office to make certain that the various interests of the Service are properly weighed. Each report concludes with the series of recommendations that are justified on the basis of the studies that have been made. In addition to showing the monetary losses or gains that will result from the impoundments as planned, the reports usually include a series of recommendations for changes in construction and operation which would be favorable for fish and game.

Since the establishment of the Office of River Basin Studies in March 1945, the sponsors have received sixty-four projects reports from the Fish and Wildlife Service. Only two of these were Texas projects; and it so happens that neither of these are located in areas having exceptional pre-project fish and game values.

One of these, the Robert Lee, a Bureau of Reclamation project on the Colorado River about seven miles below the town of Robert Lee, may be examined briefly as an example of such studies. It consists of a dam and reservoir with irrigation canals and provisions for supplying municipal water. When the irrigation pool is full the reservoir will have 19,600 surface acres; and at the average minimum pool elevation there will be 11,600 acres. The fish and wildlife evaluations on this project have not been finally approved but were reported as follows:

| | |
|---|---|
| Region above dam | $14,002 |
| Region below dam | 58,085 |
| Total both | $72,087 |

These totals represented values for waterfowl and fish in 97 miles of stream; and trapping, hunting, and nesting values for fur animals, quail and doves, on over 100,000 acres of land above and below the dam. The post-project values were estimated on the basis of the average minimum pool, area 11,600, and all the water uses proposed in operation. The annual values estimated may be summarized briefly as follows:

| | |
|---|---|
| Region above dam | $ 67,480 |
| Region below dam | 113,560 |
| Total | $181,040 |

Subtracting the value of existing fish and wildlife from the evaluation of the post-project conditions we find a net benefit to fish and wildlife values of $108,000. Hence, the Fish and Wildlife Service approves the construction of this project.

However, the interests of the Fish and Wildlife Service do not end with completion of the evaluation surveys. After study of the sponsors construction and operation plans of this project, recommendations were made which will help to mitigate losses and enhance benefits inherent in the project. Some of these are:

1. Between the dates of March 15 and May 15 each year the levels in the reservoir and in the stream below should be held as stable as possible.

2. Operation of the gates should be such as to avoid sudden releases of large volumes of water at any time or sudden decrease of outflow.

3. A minimum of 20 second-feet should be released into the stream below the dam at all times.

4. All timber and heavy vegetation should be cleared from the reservoir area to the elevation of pollution from the town of Robert Lee should be included in the relocation program for that municipality.

5. The entire project area be opened to free use by the public except such portions as may be reserved by the sponsoring agency for the purpose of safety, efficient operation, or protection of public property.

There are other recommendations but these serve to illustrate the subjects considered. As in all other projects studies, the aim is to develop the best methods of using the facilities that are being created. The reservoirs are viewed from the standpoint of their future use for the production of sport and commercial fish, as State or Federal migratory waterfowl refuges, and as public shooting grounds. For the highest usefulness of the impoundments in the interest of conservation, it is the duty of the Fish and Wildlife Service to devise means to increase fish and wildlife habitat through changes in the operation of reservoirs, trying always to keep within practicable bounds in so doing. The same observation generally applies to the lands, canals, and ditches which make up the irrigated areas. In many instances, it can be expected that, with the adoption of these recommendations, a project can be changed from the loss to the gain side of the ledger. Also, the Service sometimes recommends that long-time studies be made which will lead to proper management of the resources after the project is built. Only this combination—suitable conditions and good management—will produce and maintain maximum fish and game crops on the land and water areas to be created by the development of the Nation's rivers.

## THE COLLEGIATE ACADEMY. SELECTED PAPERS

### REPLICAS OF VERTEBRATE CIRCULATORY SYSTEMS CAST IN VINYL ACETATE

CHARLES TANDY and LOLA FONVILLE, Abilene

Ten years ago the word plastic meant little to most people. Today it occupies a substantial place in everyday life. Plastic research contributes much to industry, to science and to living.

The authors, whose knowledge of plastic compounds is limited, saw, in an article in Life, pictures of the replicas of the circulation of several animals. One is a chemistry laboratory assistant and the other a biology assistant. One also had done embalming and knew the technique. The University offered to support the project and plans were therefore prepared.

Vinyl acetate injected into blood vessels while liquid rapidly hardens. Tissues are removed by chemical maceration. The remaining replica may be studied in detail.

We chose the cat because we knew most about its anatomy. It could be easily obtained and its structure is very similar to the human body. For that reason it is used for dissection in vertebrate zoology classes. Further work was done on the rabbit and frog. Any amphibian, bird or mammal is suitable.

Vinyl acetate is a solid organic compound dissolved in acetone, or other ketone, and colored by dyes such as magenta. The compound is sold by Ward's Natural Science Establishment in three colors: red for arterial injection, blue for systemic veins and yellow for the portal circulation.

$\mathrm{C2H2+CH3COOH}$———$\mathrm{CH3COOCH=CH2}$ using a murcury catalist. Vinyl acetate is then polymerized in lienar polymers containing fifty to one hundred molecules. Polymerization can be brought by 1, irradiation with ultraviolet light, 2, bombardment with alpha particles, or 3, addition of small amounts of substances that yield oxygen or a free radicle. These large polymers are very stable to heat and light. Other valuable properties are: 1, chemical inertness (not affected by strong acid or alkali), 2, ability to harden after exposure to moisture and 3, flexibility.

The materials needed for a plastic corrosion preparation are: vinyl acetate, a 10 cc. injection syringe, an 18 gauge injection canula or needle, scissors, scapel, forceps, thread, clamps and probe. Rubber gloves are desirable for hygienic reasons. Place all materials on the table in order for rapid work.

We used a four months old cat for the first preparation killing it with methane gas. This gas is not suitable for some animals such as the frog. With suitable precautions more dangerous gases could be employed. Tie each leg of the cat to the spreading board and tilt the head back. An incision was made through the skin of the thigh avoiding any damage to femoral vessels. It was also necessary to make a midventral trunk incision to determine the extent of the injection. The femoral vessels are readily exposed with little dissection and are large enough to serve. Speed is of considerable importance because animals dead a few hours will not give as good results as those still limp and warm.

While the dissection was in progress the clean dry syringe was filled with blue vinyl acetate and the needle slipped on it. The needle was inserted in the femoral vein and the vessel was ligated. The plastic was forced into the vessel until the veins were filled. Immediately the canula was removed and the vessel was ligated tightly to prevent leakage. The procedure was repeated with red vinyl acetate in the femoral artery filling the arterial system.

When the injection process was finished the cat was placed in a vat of strong sodium hydroxide to macerate the soft tissue and bones. The chemical reaction is of some interest. NaOH plus fat tissues yields soap and glycerine. Bacterial maceration has also been suggested for removal of soft tissues. The length of time varies with the size of animal. All the frog's tissues are removed by chemical maceration overnight.

It is well to remove the specimen from the solution while some of the larger bones are still intact. The observer is then able to better orient himself and may study the close interrelationship between bones and blood vessels. For instances the nutrient vessels passing through bone foramina show up very well.

When the soft tissue has been removed by gentle washing the cast of the system is mounted in a 5% solution of formaldehyde in a suitable display jar. The cast may be left in a dry state for study. The plastic is not too brittle to handle.

The finished product is of great practical value in the zoology laboratory. The skeletal replicas of the systems may be used as a supplement to the study of fresh and preserved material in the laboratory. Oftentimes the student has difficulty in studying the circulatory system in detail from dissection. He may be handicapped by a small animal or by poor technique. These plastic preparations serve as valuable guides. They also supplement charts and diagrams in lecture work.

This field of work has vast possibilities. It may be used for other divisions of the circulatory system and for other tubular structures in the body such as kidney and lung. The authors plan to continue their studies.

# STUDIES ON LIGHT PRODUCTION IN BACTERIA

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INTRODUCTION: The ability of some organisms to produce light is a phenomenon which has long been of interest. Certain marine bacteria are luminous and furnish an interesting object for study not only from the point of view of their light production, but also for the fact that one finds here organisms in which energy is emitted in a measurable form, and when taken as an index of a vital phenomenon, can be subjected to a great variety of environmental changes and a study made of the effects of these changes on the rate of the reaction, as well as other processes.

The purpose of the present paper is to make a study of luminescence in bacteria and to determine some of the factors affecting it. The organism used in this case was **Achromobacter fischeri,** a rod form which has been isolated from sea water and from several species of salt water fish (mackerel in particular).

It has been established that light production in bacteria is an enzymatic process due to the oxidation of a substrate, luciferin, in the presence of a catalyst, luciferase, and follows the laws of enzyme reaction. Working with **Cypridina,** a marine crustacean, E. N. Harvey (1) found that after mixing luciferin and suciferase solutions a gradual decrease of luminous intensity follows the initial marked brilliancy. The effect of the enzyme luciferase is, in general, proportional to its concentration. Beijernick later found that luminescence in bacteria ceased with death and was independent of respiration.

The special medium used in cultivation of **A. fischeri** was of the following composition per liter:

| | |
|---|---|
| Beef extract | 3.0 gms. |
| Peptone | 5.0 gms. |
| NaCl | 30.0 gms. |
| Agar | 20.0 gms. |
| Riboflavin | 5.0 ccs. (10 per cc.) |

The medium was dispensed in plugged test tubes and petri dishes and sterilized in the autoclave at 121°C. and 15 lbs. pressure for 15 minutes.

EXPERIMENTS AND RESULTS: A 10-day old, non-luminous culture of **Achromobacter fischeri** growing anaerobically in a sealed test tube was obtained on Nov. 19th, 1946. The sealed tube was broken and the culture innoculated into 3 nutrient agar slants containing 3% NaCl. Bright greenish-silver luminescence was observed in the original culture within a few hours after oxygen was admitted into the tube, and luminescence could be observed in the transplanted cultures as soon as the colonies grew large enough to be seen (about 6 hrs.). These cultures remained luminous for about 72 hours. The original culture, however, lost its luminescence after 2½ days.

Microscopic examinations of the organisms in pure culture showed them to be motile, gram-positive, spore-forming rods, 1.3-2.0 microns in length by 0.4 to 0.8 microns in width. The optimum temperature for growth and light production was room temperature, although lowering of the temperature down to about 12°C. appeared not to have much effect on luminescence, except in that the low temperature slowed growth somewhat.

To determine the effect of supplying vitamins, especially riboflavin, to the medium, 5 cc. of a solution containing 1 gamma of riboflavin per cc. were added to the medium, per liter. Cultures grown at room temperature in the vitamin-enriched medium remained luminous over a much greater period of time than those grown in ordinary media. Sixteen test tube cultures containing added vitamins remained luminous for an average of 7 days, as compared to an average of 4 days for the same number of tubes containing no added vitamins. Petri plate cultures, both with and without addition of vitamins, tended to remain luminous for a longer period of time than did test tube cultures. The average period of luminescence for 6 petri dish cultures without extra vitamins was 7 days as compared to an average of 10 days for 6 petri plate cultures in riboflavin-enriched media. In all cases, the luminescence of the cultures appeared brightest about 24-48 hrs. after innoculation, after which time it faded gradually to extinction.

One interesting phenomenon which was noted in **A. fischeri** petri plate cultures was that on heavily-streaked plates, those colonies at the periphery of the streaked portion retained their luminescence longer than did those at the center. This may have been due to the presence in the surrounding medium of unused light-production factors which were most readily accessible to the outer colonies. This may also account for the tendency of test tube cultures to lose their luminescence more rapidly than plate cultures, due to the lack of a large excess of riboflavin or other light-producing factors in the medium.

Another observation made during the experiments was that the color of the **A. fischeri** colonies varied with age, fading gradually from a greenish yellow to a dull white. Once a culture has faded to the white color, it will not revert back to the yellow form. Transplants showed little luminescence, although they remained viable.

Attempts made to cultivate **A. fischeri** on strips of raw mackerel and in media containing boiled fish extract and NaCl were unsuccessful.

Two brightly luminous plate cultures, streaked in different designs, were photographed successfully by their own light, using a Graflex camera and an exposure of 8 hrs. at F-8 on superspeed panchromatic press film of Weston Speed 100, which produced well defined negatives.

SUMMARY: Luminescence in bacteria is due to an oxidation of the substrate luciferin in the presence of the catalytic enzyme, luciferase. A great variety of environmental changes, age of culture, and addition of riboflavin to the medium are some of the factors influencing the brilliance and length of luminescence.

**A. fischeri** grows best at room temperature, on nutrient media containing added riboflavin and 3% NaCl. Colonies may be yellow to dull white in color, depending chiefly on the age of the culture. Luminescence is a soft silvery-green in **A. fischeri,** and is produced in sufficient quantity to enable photographs to be made of cultures, using no other light than that from the colonies themselves. The organisms remain luminous, depending upon the circumstances, from 3 to as many as 16 days, the overall average being approximately 7 days.

The writer wishes to take this opportunity to express her deepest appreciation for the help and advice given by Dr. Orville Wyss and Dr. O. B. Williams, of the Bacteriology Department of the University of Texas.

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## IDENTIFICATION OF SUGARS IN LIGUSTRUM BERRIES

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The shrub called Ligustrum is a cultivated plant belonging to the Oleaceae family. Some familiar members of this family are: the lilac, fragrant olive and privet. The plants on the campus of Mary Hardin-Baylor University are ten to fifteen feet high, and in the summer form clusters of berries that turn purple in the autumn. It was suggested that I choose some local plant for study, so attracted by the faint fragrance of the berries I decided to test them for sugars.

Because the water extract of the berries gave a definite positive test for reducing sugar with both Fehling's and Benedict's solutions, and gave glucosozone with phenylhydrazine reagent, I decided to study this extract further.

The methods of extraction given in Morrow's Biochemical Laboratory Methods were used here. The first step was to grind the berries and reflux them for several hours with dilute sulfuric acid. This acid hydrolysis would tend to convert any glucoside which might be present into its component sugars. After filtering the refluxed material through a Buchner funnel, the filtrate was neutralized with sodium carbonate. The insoluble barium sulphate which was formed during the neutralization was filtered off. The excess barium ion which remained in the filtrate was removed by cautiously adding dilute sulfuric acid until no more precipitate was formed.

Testing the neutral solution with Fehling's again gave a positive reaction. Tested with Phenylhydrazine for osozones it gave wavy hairy shaped crystals which were similar to the photomicrographs of rhamnosozones. This was interesting because rhamnose, a methyl pentose sugar is somewhat rare. Since the fresh water extract of the berries yielded glucosozones abd the hydrolyzed solution yielded what appeared to be rhamnosozones, it would appear that the rhamnose occurred in the berries as a glucoside. Rhamnose in plants is usually combined with other sugars as glucoside.

Lemon flavin or quercitrin from black oak bark, and xanthohamnin, the coloring matter found in Persian berries, are the best known glucosides from which rhamnose may be derived. Xanthorhamnin is known to yield galactose, rhamnose and rhamnetin on hydrolysis (1). Actually the enzyme rhamnose acts on xanthorhamnin to give a trisaccharide sugar, rhaminose. This, on hydrolysis with dilute acids, yields two molecules of rhamnose and one molecule of galactose (2).

In order to test the theory that Ligustrum berries contain Xanthorhamnin as does Persian berries, another group of berries was refluxed for several hours with 95% ethyl alcohol. The alcohol should destroy all possible enzyme action. Again the Fehling's test was positive and glucosozones only were formed with phenylhydrazine.

Still other berries were ground and allowed to stand over night in distilled water to permit enzyme action. The enzymes in the plant are found between the cells and do not act until the plant tissue has been destroyed, (1). The filtrate from these gave a positive Fehling's test and what seemed to be a few galactosozones and possibly a few lactosozones. A few other forms of crystals were present, probably formed from other reducing compounds found in the berries. No rhamnosozones were found.

Because a fresh water solution of the berries gave the glucosozone only, and a solution that had undergone enzyme action yielded galactosozomes, it would seem that the enzyme might be responsible for changing glucose to galactose. Several attempts were made to isolate both glucoside and glucose unsuccessfully. However when the hydrolyzed solution was concentrated under diminished pressure, it gave a thick sweet smelling syrup. Crystals never formed because of the extrame solubility of the sugar. Another experiment produced a thick syrup from an alcoholic extract of the fresh berries which formed some crystals and gave the glucosozone test.

My experiments with the purple berries of Ligustrum have shown that they contain free glucose and probably a glucoside that contains rhamnose and galactose. The galactose is liberated by the action of enzymes, while rhamnose and other reducing compounds are formed by hydrolysis with sulfuric acid. In further experiments I hope to isolate the glucoside and pure glucose from the berries.

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# STUDIES ON THE ENDOPARASITES OF THE TEXAS HORNED LIZARD, PHRYNOSOMA CORNUTUM (HARLAN)

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A number of papers on the internal parasites of reptiles have appeared during recent years. There are, however, many problems relative to the incidence, morphology, and cultivation of these forms which have not been adequately treated in any of the published reports. During the past two years, studies on the endoparasites of Texas reptiles, especially of lizards and snakes, have been carried on in our laboratory by a group of advanced biology students. The present paper is based on a part of this work. **Phrynosoma cornutum,** the Texas horned lizard, was selected as the host animal to be reported on at this fiftieth anniversary meeting of the Academy because it is an exceptionally well-known species and occurs throughout most of the state.

MATERIALS AND METHODS: The lizards were killed by injecting ether into the body cavity. The viscera were removed and placed in 0.7% saline. These organs, as well as the oral and abdominal cavities, were examined for parasites. The parasites encountered were several species of protozoa and one species each of roundworn, tapeworm, and Acanthocephalan. Cover glass smears of the protozoa were in some cases fixed with Bouin's fixative, stained with Haidenhain's iron alum haematoxylin, and mounted in balsam, while others were prepared according to the method proposed by Morrison (1946). The roundworms and the Acanthocephala were fixed in hot 70% alcohol and preserved in the same fluid, while the tapeworms were flattened between two glass slides and fixed either with Bouin's fixative or with formalin-acetic-alcohol. Several specimens of each of the types of worms were stained with borax carmine, cleared with beechwood creosote and mounted in balsam.

Cultures were also made of the protozoa using as a medium one-half strength Ringer's solution containing 0.2% gastric mucin and a small amount of Bacto Loeffler's dried blood serum as nutrients. Original inoculations were made from the large intestine of the lizards and contained the bacteria present therein. Attempts were made to obtain pure cultures by:

(1) adding 100 units of penicillin per cc. of medium

(2) adding 0.1 cc. of a 1% solution of acetic acid

(3) adding both (1) and (12)

## EXPERIMENTAL DATA

**Observation on Incidence.** A total of 27 lizards was examined. Out of the total 12 (44.4%) were males, 7 (25.9%) were females, and the sex of 8 (29.6%) was not determined. The incidence of protozoa, roundworms, and tapeworms in the animals examined is indicated in Table I.

Table I. Occurrence of parasites in **Phrynosoma cornutum** in Texas

| **Parasite** | **Males** | **Females** | **Sex Undetermined** | **Total** |
|---|---|---|---|---|
| Protozoa | 75% | 100% | 50% | 74.1% |
| P. phrynosoma | 58.3% | 71.4% | 62.5% | 62.9% |
| D. phrynosomatis | 42.6% | 42.8% | 62.5% | 48.1% |

By referring to the above table, it may be noted that the female lizards were apparently more susceptible to infestation with protozoa and roundworms than were the males, while the percentage of animals infested with tapeworms was approximately the same in the two sexes. However, the total number of host animals examined was not sufficiently large to warrant any definite conclusions.

**Morphology and Identity of Parasites.** All of the nematodes examined during this investigation were found in the stomach of the host and were identified as **Physaloptera phrynosoma** (Ortlepp, 1922). Members of the genus **Physaloptera** are characterized by two large triangular lips armed with teeth on their inner surface. **P. phrynosoma** can be distinguished from other species by the arrangement of the teeth, as well as by the structure of the caudal region in both sexes.

The tapeworms encountered in the horned lizards examined were usually present in the small intestine although they were occasionally found also in the large intestine. These worms were identified as **Diochetos phrynosomatis** (Harwood, 1932). This species is a flat, white tapeworm, composed of relatively few elongate segments. The total length varies from 55 to 70 mm. There is no line of demarcation between the neck and the scolex. The mature segments are 15 or 20 mm. from the scolex. They vary considerably in length but are always much longer than broad.

Only one host animal harbored a species of Acanthocephalan or spinyheaded worm. There were four worms present between the peritoneum and the body wall, toward the liver. These specimens were only recently obtained and consequently have not yet been completely identified. The worms are only about 3 mm. in length and exhibit the distinctive features of the group to which they belong, including the absence of a body cavity and digestive tract, a more or less flattened body, and a spinous retractile proboscis.

The protozoa were found most commonly in the large intestine but were, in a number of instances, present also in the small intestine. There were in many of the host animals, two species of flagellates, one of which is apparently a **Trichomonas.** Some of the lizards also contained a ciliate protozoan. Specific identification of these forms has not yet been made.

**Cultivation of Protozoa.** The ciliate protozoa grew readily in the culture medium employed. Cultures maintained for three weeks without transfer and to which no additional nutrients were added still contained large numbers of the animals. Pure cultures were not obtained by any of the methods tried. Tubes to which acetic acid was added showed little decrease in the numbers of bacteria, but the ciliates grew readily. The penicillin decreased the bacterial content of tubes and also the percentage of protozoa, while the combined penicillin and acetic acid inhibited the growth of both bacteria and protozoa. It is likely that the ciliates feed on the bacteria and for that reason did not survive when bacterial growth was prevented.

The flagellates also developed in the medium used, but they did not persist as long. Transfers every few days were necessary in order to maintain these forms. Wenrich (1945) found that flagellates survived in individual culture tubes for as long as 180 days if nutrient materials were supplied as needed and if distilled water was added to replace that lost by evaporation.

Further culture experiments are being carried out in order to determine the survival of the protozoa under various conditions and also in an attempt to obtain pure cultures of at least some of the forms.

## SUMMARY

The Texas horned lizard, **P. cornutum** was found to harbor a tapeworm, **Diochetos phrynosomatic,** a roundworm, **Physaloptera phrynosoma,** several species of protozoa, and rarely, an acanthocephalan.

The incidence of infection was highest for protozoa, while the roundworms occurred more frequently than the tapeworms. Female hosts were apparently somewhat more susceptible to infestation than were the males.

A ciliate protozoan obtained from **P. cornutum** was easily cultivated in a medium consisting of one-half strength Ringer's solution containing 0.2% gastric mucin and a small amount of Bacto Loeffler's dried blood serum. Since attempts to obtain pure cultures of this ciliate were not successful, it is thought that the protozoa may require the bacteria as food. Flagellates from this lizard also grew in the same medium but did not persist as long without being subcultured.

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